Short Right Leg Syndrome

by Erik Dalton, Ph.D., Certified Advanced Rolfer

Excerpted from *Advanced Myoskeletal Techniques, Vol. 1, Elements of Structural Integration*

A hotly debated and exceptionally significant postural issue begging for a logical and practical explanation is the short right leg syndrome. An inferred awareness of the existence of leg length asymmetry has existed for thousands of years and despite decades of research questioning how leg length differences relate to chronic pain and somatic dysfunction, the topic remains controversial. Several published studies measuring leg length on people and skeletons surfaced during the late 1800's[1,2] and investigations of this complex phenomenon continue today.

The primary determinant in creating and perpetuating functional leg length discrepancies is the direction of ilial rotation on the sacrum – often termed iliosacral rotation or tilt. The key for understanding many distorted and pain-generating postural patterns is derived from both biomechanical *alteration* of iliosacral rotation (functional) as well as true leg length inequalities (structural or anatomic). Structural limb asymmetries are often influenced by hereditary factors, disease, trauma, unequal bone development, growth plate compression, etc.

The confusion amid controversy regarding repercussions from limb length discrepancy is primarily driven by the complexity of neuromyofascial forces acting on the three bones of the pelvis (pelvic bowl) often leading to dysfunction. While iliosacral rotation primarily governs leg length discrepancy, proper functioning of the sacroiliac joints is determined by the ten ways the sacrum becomes asymmetrically fixated between the two innominates. Both iliosacral and sacroiliac disorders are intimately affected by various internal and external forces such as altered muscle firing order patterns, motor and vestibular dominance, tonic neck reflexes, cranial imbalances, viscerosomatic influences, embryologic development, and life's little micro and macro traumas.

In two exquisitely designed research studies, Denslow and Chase measured leg length discrepancy first in 361 subjects (1962) and subsequently in 294 subjects (1983)[3]. Using the most advanced radiographic technology available at the time, their papers reported the following findings concerning structural short right leg syndrome:

- Significant incidence of low right femoral heads;
- Lumbar convexity to short leg side (sidebent left / rotated right); and
- A high correlation depicting contralateral pelvic rotation.

These authors' findings suggest that *both* innominate bones rotate around the sacrum (iliosacral tilt), and the innominates and sacrum have the additional propensity to rotate as a block around the vertical lumbar spine. Because Denslow and Chase's research included pelvic rotation in both the horizontal and sagittal planes, their work proved instrumental in shaping the biomedical community's understanding of the compensatory mechanisms involved in postural adaptations to short leg and sacral base unleveling.

Denslow and Chase's short right leg data not only confirmed leg length findings conducted by early researchers but also laid the foundation for new, more sophisticated studies by investigators such as John H. Juhl, DO.[4]

In Table I, historic references are presented detailing research papers comparing femoral head unleveling and the percentages of short *right* versus short *left* legs beginning with Schwab in 1932 and ending with Juhl in 2004.

PAIN MANAGEMENT AND PELVIC OBLIQUITY

A prerequisite for all pain management and structural integration therapists requires a

Comparison With Historic References for Relative Quantitative Difference on the Short or Low Side of Leg Length Inequality

		Δ Femoral Head Unleveling as Percentage of Total*			
Investigator	Subjects Studied (No.)	≥4 mm	≥10 mm	≥15 mm	Short Right Leg
Pearson, 1951	Children aged 5–13 y (736)	81.0%	4.0%	...	44.0%
Pearson, 1949	Children aged 5–13 y (710)	78.0%	2.0%	...	45.0%
Schwab, 1932	Adults (540)	...	64.0%	...	...
Kerr, 1943	Adults with low back pain (150)	62.0%	...	...	54.0%
Rush, 1946	Control subjects (100) Soldiers with low back pain (1000) Control subjects (50)	33.0% 37.5 %	4.0% 15.0%	... ...	66.0% 55.0%
Stoddard, 1959	Adults with low back pain(100)	86.0%	17.0%	...	...
Denslow, 1962	Male medical students (361)	48.0%	9.0%	...	66.0%
Giles, 1981	Control subjects (50) Adults with low back pain (1309)	... ...	8.0% 19.0%	... ...	... ...
Friberg, 1983	Control subjects (359) Adults with low back pain (653)	44.0% 75.0%	15.6% 18.4%	2.2% 11.7%	53.0% ...
Juhl, 2004	Patients with low back pain (421)	66.0%	28.0%	7.1 %	68.0%

basic understanding of the relationship of iliosacral unleveling and short leg syndromes. In the absence of radiographic measurements, therapist must develop keen palpatory and visual skills to aid in proper evaluation of bony and soft tissue landmarks. As Sir William Osler eloquently stated, "In order to treat something, we must first be able to recognize it". Any attempt to tackle the short right leg syndrome armed with inadequate assessment and treatment tools will undoubtedly lead to failure and frustration. This common pelvic obliquity strain pattern must be understood and corrected before proceeding to more complex sacroiliac and lumbar spine dysfunctions although strain and imbalance in either of these associated structures can *also* influence limb length discrepancy.

Addressing this perplexing structural condition early in the treatment session often sympathetically corrects lumbosacral and sacroiliac strain patternsÖbut not always. Therefore, this chapter will seek to "weed-through" possible explanations for the existence of iliosacral rotation while attempting to uncover the rationale behind frequently occurring functional and structural short right legs.

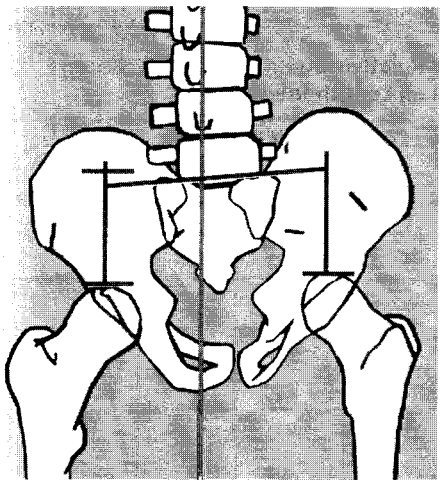


Fig. 1. Anatomical Short Right Leg with Low Femoral Head
Many osteopathic, chiropractic and structural integrators base assessment and treatment protocols on the assumption that a functionally short *right* leg results from posterior/superior ilial rotation which would elevate the ipsilateral innominate. However, in the above example a common pattern is depicted where the client presents (radiographically) with a low femoral head accompanied by an anatomic (true) short leg during standing.

SHORT ANATOMIC RIGHT LEG... LOW FEMORAL HEAD?

For years, many osteopaths, chiropractors, and structural integrators have based therapeutic protocols on the assumption that a functionally short leg results from posterior/superior ilial rotation on the side of the ipsilateral leg (Fig. 1). This short-leg observation seems obvious since the ilium should be moving superiorly in order to "hike" the innominate and pull the leg up with it. Following this line of thought, a long leg should result from anterior/inferior ilial rotation on the ipsilateral side.

Although this observation can be a causal factor in pelvic obliquity, other possibilities also exist. Figure I depicts a very common pattern where the client presents (radiographically) with a low femoral head accompanied by an anatomic (true) short leg during standing. Studies mentioned earlier indicate the presence of a greater number of true short legs in the general population than was previously reported. And to add to the confusion, another common pattern invades our practices when clients present with a functionally short right leg combined with an anterior/inferior rotated ilium. This intriguing postural pattern will be discussed in greater detail later in the chapter.

Both therapists and researchers have extensively studied the anatomic and functional leg length theories and noted that gravitational forces should surely cause one to lean to the short leg side thus creating greater compression and shortness via foot hyperpronation, knee buckling, etc. Many justify this theory with analogies such as this: "Any mechanical engineer will tell you that when measuring weight distribution on structures such as the Leaning Tower of Pisa, the greatest amount of compressive force will be concentrated on the side to which this magnificent structure is leaning" (Fig. 2). The most striking problem with this analogy is that the Tower of Pisa does not possess a central nervous system.

COUNTERINTUITIVE POSSIBILITIES

The central theme in *Myoskeletal Zone TherapyÆ* is the influence of cerebral lateralization due to predictable fetal positioning during the third trimester of embryologic development. Left vestibular (balance) dominance caused by maternal acceleration and fetal inertia (back and forth fetal movement during the mother's gait) stimulates the baby's left utricle. Considered the major organ of the vestibular system, the utricle supplies a steady stream of updated data concerning position and movement of the head. Each of the semicircular canals – anterior, posterior and lateral – lie anatomically in different planes with each plane intricately placed at right angles to the others. Thus, the combined functioning of these elaborate inner ear structures deals with different movement: up and down, side to side, and tilting from one side to the other.

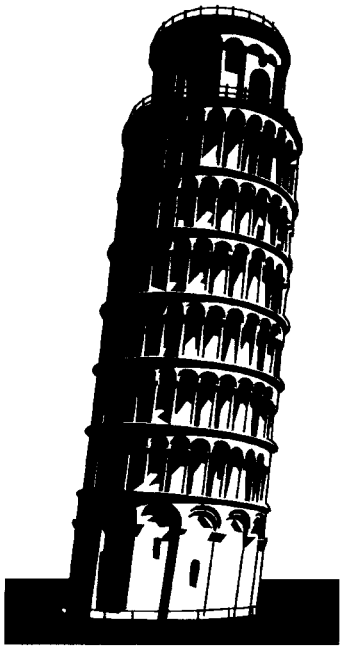


Fig. 2. Leaning Tower of Pisa
Following the Laws of Gravity, any mechanical engineer will tell you that greater weight-bearing will occur on the side to which the structure is leaning. The most striking problem with this analogy is that the Tower of Pisa does not possess a central nervous system.

Cerebral lateralization seems an influential factor in addressing the perplexing but fascinating question of limb length discrepancies. An in-depth discussion of these theories is presented in the *Myoskeletal Zone Therapy* chapter but an introductory overview is also necessary.

LEFT FETAL LIE, LEFT OCCIPUT ANTERIOR, AND POSTURE

Eighty percent of people presenting in the most common fetal position, a left fetal lie (left occiput anterior), are left vestibular and

right motor dominant. Vestibular dominance controls balance and tends to travel ipsilaterally up and down the spine. Therefore, in a clinical setting, we often see clients compressively loading the balance dominant left leg during stance. This is one of the major reasons the left thigh and foot are larger on most people (remember momma and the shoe clerk making you try on the left shoe?)

Since motor cortex dominance crosses over contralaterally, the right-sided extremities (arms and legs) perform most motor dominant tasks, such as throwing and kicking (Fig. 3). The postural muscles, particularly the hip flexors and their synergistic stabilizers (adductors, TFL, piriformis, etc.) react to right motor dominance by tightening and shortening. Tightening of these postural muscles and their synergistic stabilizers typically increases lumbar lordosis and pelvic tilt on the client's right side as the right innominate is pulled in an anterior/inferior direction by the iliopsoas, rectus femoris, etc. (Fig. 4).

To maintain pelvic balance, the brain recruits the contralateral quadratus lumborum (QL) and lateral head of iliocostalis to help counterbalance the uneven A/P forces traversing the pelvic bowl. The QL has a propensity for flattening lumbar lordosis and "hip-hiking" the left innominate (posterior/superior rotation). This pelvic girdle rotational adaptation forms the primary functional support system described in Dr. J. Gordon Zink's *Common Compensatory Pattern* discussed later in the chapter. Regrettably, this aberrant anterior/posterior rotational pattern establishes the *uneven base* upon which the lumbar spine must respond causing spinal, myofascial and diaphragmatic compensations to be reflected through the upper cervical complex, the temporomandibular joint and into delicate cranial structures.

As the right innominate anteriorly rotates, it drags the upper right pole of the sacrum with it creating a left on left sacral torsion as illustrated in Figure 4. The lumbar spine must counter by sidebending left and rotating right. The resulting tug on the pelvic diaphragm is usually not a perplexing problem as long as the thoracolumbar spine makes compensatory adjustments (sidebends left/rotates right) allowing the respiratory diaphragm to counterbalance by stretching in an opposing direction. An in-depth evaluation of the effects of spinal decompensation in the four transitional zones and resulting altered diaphragmatic function is discussed in greater detail in the following chapters.

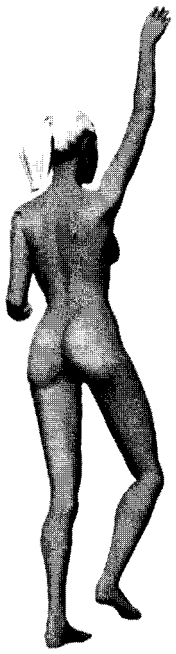


Fig. 3. Left Vestibular/Right Motor Dominance. Vestibular dominance controls balance and tends to travel ipsilaterally up and down the spine. Therefore, in a clinical setting, we often see clients compressively loading the balance dominant left leg during stance while performing activities with arms and legs on motor-dominant side.

During gait, all muscles attaching above and below to the asymmetrical pelvic bowl must adapt to the hip abduction imbalance pattern. The flexors, extensors, rotators, and lateral flexors are all dramatically affected by right motor and left vestibularly induced pelvic tilt and shift - depending, of course, on how much compensation is present.

PERSONAL PERSPECTIVES ON MUSCLE SUBSTITUTIONS PATTERNS

In an attempt to combine many of my favorite researchers' postural models (Zink, Janda, Previc, Geschwind, Pope, Greenman, etc.) into some sort of reasonable therapeutic protocol, I have come to recognize certain predictable substitution patterns that develop from vestibular and motor dominant neurological adaptations. In my opinion, the pelvic muscles that hold the greatest liability for creating and perpetuating dysfunction during vestibularly-driven left pelvic sideshifting areÖthe *gluteus medius and minimus*. My respect for these often neglected muscles has grown with increased observation and study. I now place them on a level with the following distinguished antigravity structures: (Fig. 5)

• Transversus abdominis: Through its intimate connection with the thoracolumbar fasciae, multifidus and sacrospinous ligaments, the transversus should not only brace the lumbar spine during forward bending, but also help lift the ribcage off the pelvic girdle with each step.

Fig. 4. Anterior/Inferior Rotated (tilted) Innominate. The pelvic girdle rotational adaptation above forms the primary functional support system described in Dr. J. Gordon Zink's *Common Compensatory Pattern.* Tightening of the hip flexors and their synergistic stabilizers typically increases lumbar lordosis and pelvic tilt on the client's right side moving the right innominate in an anterior/inferior direction. To maintain balance, the brain often recruits the contralateral QL and iliocostalis to counterbalance the strong torsional forces of the right hip flexors. As the right innominate anteriorly rotates, it drags the right sacral sulcus with it creating a left on left sacral torsion.

• Hip flexors/extensors: Optimum hip extension firing order during the walking cycle should be: rectus femoris (extend the knee), ipsilateral hamstrings, ipsilateral gluteus maximus, contralateral lumbar erectors, and ipsilateral erectors. Anterior hip capsule adhesions often inhibit the antigravity function of these muscles resulting in aberrant firing order substitution patterns.

The proclamation concerning the importance of gluteus medius/minimus as primary antigravity structures deserves further explanation.

ABDUCTION FIRING ORDER SUBSTITUTION PATTERNS

As discussed in an earlier chapter on firing order patterns, during hip abduction (raising the extended top leg toward the ceiling while in a sidelying position), gluteus medius and minimus should fire first followed by tensor fasciae latae, piriformis, quadratus lumborum, and ipsilateral lumbar erectors.

To test the firing order in hip abduction, simply assume a left sidelying position and raise (abduct) the fully extended right leg toward the ceiling. The gluteus medius/minimus should fire first followed by their synergistic muscles listed above.

However, during weight-bearing, the gluteus medius/minimus perform a completely different function. During the normal walking cycle, the right gluteus medius/minimus must fire during the stance phase to "cock" or lift the contralateral pelvis (right pelvic sidebending) so the left leg can swing (Fig. 6). It is imperative that the right gluteus minimus/medius be the first muscles recruited to elevate the contralateral hip so the synergistic stabilizing muscles can perform their specific duties.

All sorts of aberrant muscle substitution patterns can be singled out during the "hip abduction sidelying test" and through keen observation of a client's gait. These distorted patterns indicate loss of primary antigravity function throughout all lumbopelvic structures. Although some substitution patterns wreak more havoc that others, all create biomechanical breakdown in people whose bodies are unable to compensate at the four transitional zones (lumbosacral, thoracolumbar, cervico-thoracic, and cervicocranial.)

HERE'S THE CATCH

During prolonged standing, the client's body weight routinely shifts over the vestibularly dominant left leg eventually creating stretch weakness in the left gluteus medius/minimus. This pattern can be easily tested in your own body to offer clues as to your pattern, e.g., are you *ideal* (equal fascial bias in all four zones), do you follow the L/R/L/R *common compensatory pattern*, or are you follow a L/R/L/R *uncommon compensatory pattern*?

Stand with all your weight on the left leg while the fingers of your left hand palpate the left acetabulum (lateral hip) and relax your body. (You may have to hold on to something to reproduce the feeling of prolonged relaxed stance.) Do you feel the hip pop out laterally against your fingers? Now test the right side to see if it pops out *more* during normal weight bearing. If the acetabulum on the right "gives" more, it is likely that your structure follows an *uncommon compensatory pattern*.

Those that feel a stretch weakness on the right side probably fall within the 20 percent that Zink defined as *uncommon compensatory pattern*. Some will not feel stretch weakness in the gluteus medius/minimus during prolonged standing. This small percentage of the population where there is equal fascial bias at all four transitional zones would be considered "ideal", indicating no rotational preference at the lumbosacral, thoracolumbar, cervicothoracic, or cervicocranial junctions.

Those with a supine anteriorly/inferiorly rotated right ilium (most common) should feel the left acetabulum pop out more to the left during left leg loading indicating weakness in these primary abductor muscles. Pay attention to people in public, such as grocery checkers, hairdressers, assembly workers, etc., as they stand in prolonged positions with weight load-bearing on one

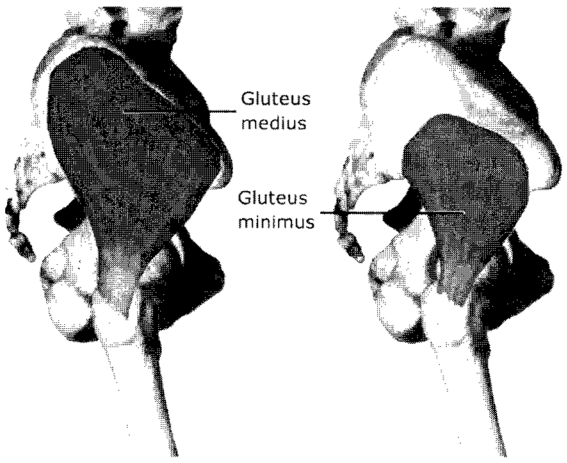


Fig. 5. Gluteus Medius/Minimus Muscles, Abductors and Internal Rotators.
The pelvic muscles that portend the greatest liability for creating and perpetuating dysfunction during vestibularly-driven left pelvic sideshifting are the gluteus medius and minimus. They should fire first in hip abduction. The firing order should proceed with TFL, piriformis QL, and ipsilateral lumbar erectors. Inferior fibers of gluteus medius/minimus also function as hip internal rotators.

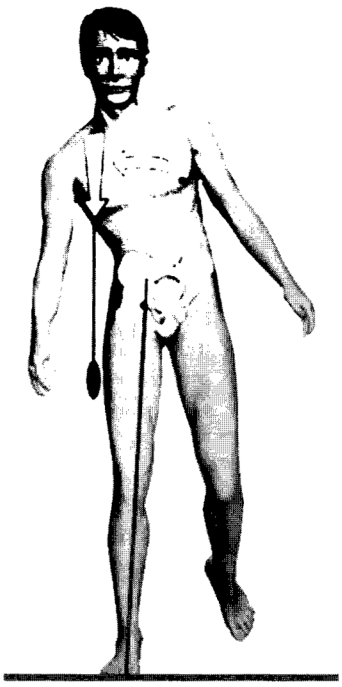
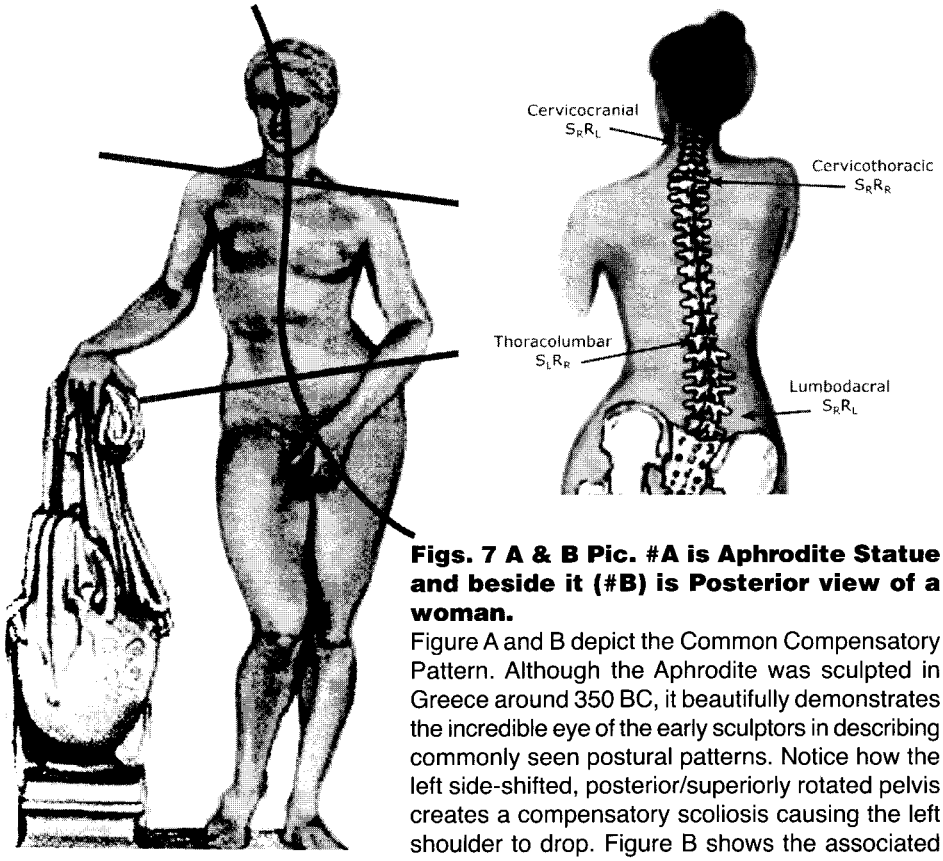


Fig. 6. Firing of Gluteus Medius/Minimus during the Stance Phase.
In the normal walking cycle, the right gluteus medius/minimus must fire first during the stance phase to "cock" or lift the contralateral pelvis (right pelvic sidebending) so the left leg can swing through. It is imperative that the right gluteus minimus/medius be the first muscles recruited to elevate the contralateral hip so the synergistic stabilizing muscles can perform their specific duties.



Figs. 7 A & B Pic. #A is Aphrodite Statue and beside it (#B) is Posterior view of a woman.
Figure A and B depict the Common Compensatory Pattern. Although the Aphrodite was sculpted in Greece around 350 BC, it beautifully demonstrates the incredible eye of the early sculptors in describing commonly seen postural patterns. Notice how the left side-shifted, posterior/superiorly rotated pelvis creates a compensatory scoliosis causing the left shoulder to drop. Figure B shows the associated spinal biomechanical adaptations inherent in Zink's and Janda's postural models.

leg. Recall that the acetabulum will slightly protrude left as the gluteus medius/minimus give to the ipsilateral side during stance. Figures 7 A & B demonstrate the biomechanics of the *common compensatory pattern* as seen in the famous sculpture of Aphrodites and the accompanying illustration depicting a posterior view of the identical pattern.

ON A PERSONAL NOTE

Those of us old enough to remember the famous Marilyn Monroe walk can visualize how her pelvis shifted side to side rather than in an ideal smooth anterior/posterior patterned gait. Weight-bearing during the stance phase caused Marilyn's pelvis to sideshift toward the *weight-supporting* side. In this instance, her weight was greater on the short leg side (Leaning Tower of Pisa) during gait which is usually the case in people presenting with a *true* short leg. However during prolonged standing, if Marilyn followed a left vestibularly dominant pattern, one would expect the weight-bearing *left* hip to pop out laterally. This dysfunctional gait is easy to recognize when viewing old Monroe films. Her right acetabulum would protrude laterally with each step. A dear friend, Peter Lawford, enjoyed telling the story of how Marilyn concocted this unique walk. Apparently, she began by first cutting one inch off her left high heel shoe and walked in the unbalanced heels for a few weeks until the left gluteus medius/minimus overstretched allowing the hip to pop out and swing laterally. After a couple of weeks she would switch shoes and remove an inch from the opposite heel. Marilyn gradually increased the amount cut off each heel and continued with the experiment, switching back and forth between shoes, until she finally created an aberrant muscle imbalance pattern that would evolve into the famous Marilyn Monroe "hip-swing."

AND THE BEAT GOES ON...

During gait with body weight shifted over the short right leg, the right gluteus medius/minimus and associated hip abductors really have to be strong to develop enough contractile force to "hike" the contralateral left hip high enough to allow the long left leg to swing through. Usually the brain aids in the process by recruiting the right tensor fasciae latae (TFL), sometimes in conjunction with piriformis, to help elevate the left hip. Of course, the down side of this substitution pattern is that the TFL eventually overpowers the gluteals, becomes hypertonic and short, and begins an unmerciful pull on the iliotibial tract (Fig. 8). I have found this common, but abnormal TFL firing order substitution pattern as a major contributor to many conditions such as iliotibial band friction syndrome, especially in amateur and competitive athletes.

Conversely, on the left side a prevalent hip abduction substitution pattern develops as the brain is forced to recruit the QL muscle to fire first due to an extremely stretch-weakened gluteus medius/minimus muscle group. This pervasive and devastating pattern causes further ipsilateral posterior innominate rotation, flattening of lumbar lordosis, left sidebending of the lumbars, tractioning of the 12th rib, and eventual back pain. These folks are easily recognized as they sidebend their torso left to allow the right leg to swing through. Therapists often mis-assess this pattern since it appears that the right side is doing

Fig. 8. TFL and Iliotibial Tract.
A common substitution pattern for stretch-weakened gluteus medius/minimus is the TFL. The brain frequently recruits TFL to help in abduction efforts. However, the TFL eventually overpowers the gluteals, becomes hypertonic and short, and begins an unmerciful pull on the IT band occasionally leading to IT-band friction syndrome.

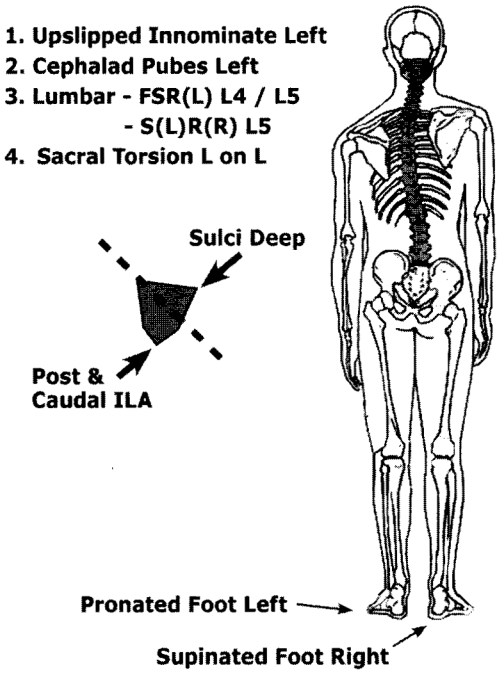


Fig. 9. Most Common Pattern Resulting from Short Right Leg.
This illustration depicts the following predictable pattern: Short right leg, descended right pubis, anterior/inferior rotated right ilium, left posterior/superior ilium, substitution muscle imbalance patterns in hip extension and abduction, left-on-left forward sacral torsion, functional right convex lumbar scoliosis, various type 1 group compensatory curves and non-neutral spinal fixations finally compensating in the upper cervical complex to level the eyes.

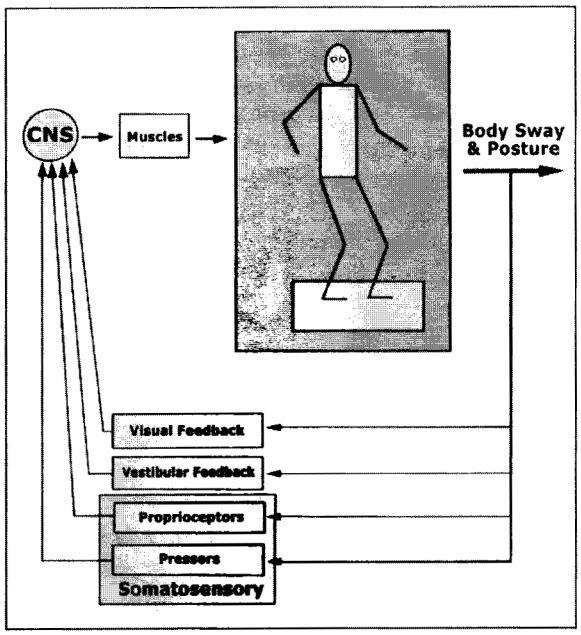


Fig. 10. Feedback Mechanisms that Contribute to Proper CNS Functioning.
Typically, the body's innate wisdom immediately begins correcting the limb length strain pattern with information gleaned from proprioceptors on the bottom of the feet that sense weight imbalance and body sway. The antigravity function of posture relies on these cutaneous receptors which are joined by visual, vestibular, and other somatosensory systems that constantly inform the CNS as to the body's position and movement.

all the work of pulling up the right hip and leg. If the trunk does not left sidebend during the left stance phase of gait, it is possible that they *are* lifting with their right side.

Try the sidelying hip abduction test to determine if you are one of many who are left vestibular dominant and presented in a left fetal lie pattern. Then have someone skilled in measuring anatomic landmarks check your landmarks while in a supine position to see if you fit the common compensatory pattern of a short right leg and anterior/inferior rotated ipsilateral ilium.

During the left sidelying hip abduction test, frequently the gluteus medius/minimus, TFL and piriformis will all fire together, indicating that they are combining forces due to weakness in the gluteus medius/minimus. During the right hip abduction test, look for the quadratus to fire first (indicated by dipping in the 12th rib area) followed by either TFL or the inhibited gluteus medius/minimus. This substitution pattern is a major pain generator and suggests gluteal weakness from excessive weight bearing during the stance phase.

The observations described above are only meant as an overview of a particular muscle imbalance pattern I have found interesting to work with in my practice and I remain unaware of any studies performed to verify these findings. Therefore, these conclusions may or may not prove to be accurate in all cases, e.g. clients presenting with fixed scoliotic patterns, sacralizations, hemipelvis, etc. Test your clients using hip hyperextension and hip abduction tests presented in *Myoskeletal Alignment Techniques Volume I* and see what correlations (if any) you find using this neuromyoskeletal theory.

PATTERNS MOST COMMONLY ENCOUNTERED

Now that a brief overview of vestibular lateralization, firing order and muscle substitution patterns have been discussed, the short leg theories resulting from a posterior/superior rotated ilium can be revisited. Although all the long-held assumptions suggesting that a long leg develops as the hip drops (anterior/inferior) seems to make perfect sense, these are not patterns I commonly see in my practice. The following is a structural formula I look for and expect to see in a majority of new clients presenting for an initial structural evaluation (Fig. 9):

- Short right leg (supine);
- Descended right pubis;
- Right anterior/inferior ilium (supine);
- Left posterior/superior ilium (spring test prone);
- Substitution muscle imbalance patterns in hip extension and abduction;
- Left-on-left forward sacral torsion;
- Functional lumbar scoliosis convex right;
- Various compensatory type I group curves resolving at O-A to level the eyes;
- Scattered non-neutral dysfunctions (facet joints stuck open or closed), and
- Associated muscle/visceral/diaphrag-

matic imbalance patterns.

The degree of compensation may largely depend on:

- Degree of leg length discrepancy;
- Functional or true leg length problem;
- Associated traumas: acute, collective, or degenerative;
- Presence of tonic neck reflexes;
- Cranial deviations causing re-patterning from the top down; and
- Viscerosomatic dysfunction.

SHORT FUNCTIONAL RIGHT LEG, ANTERIORLY TILTED ILIUM AND A LOW FEMORAL HEAD?

The question I have asked myself for years is this: "What biomechanical mechanism is acting on the iliosacral joint in the presence of an anterior/inferior right rotated ilium and a functional short right leg?" While hanging out in clinic one day with a friend, colleague and manipulative osteopath, Ross Pope, he has helped me better understand the process when I posed the question, "What pelvic mechanics are involved in clients/patients presenting with low femoral heads and functional short legs?"

While viewing radiographic postural films, he answered with these statements: "As you see in this example, this patient presents with a low femoral head and accompanying *anatomic* short right leg when standing. A functional leg length discrepancy is noted upon clinical examination when the patient is in a supine position. In this case the leg itself appears to be shorter as viewed by comparing the medial malleoli. The ilium on the "functionally" short side is anteriorly rotated which places the femoral head in a more *cephalad position in an off-weighted position.*"

Bottom line he says: "In the overwhelming majority of cases, the leg that appears to be functionally short and the leg that is actually short *are the same.* So, yes there is usually a low femoral head on the right (standing) with a short right leg (supine). The corollary to this is a low left femoral head with a functionally short left leg, which is also prevalent but less so."

He paused, reflected on what he was about to say, and continued with this stipulation: "On the other hand, there are exceptions to, or disparities in, these typical findings. For example, on occasion you will see a low femoral head height on the left with a functionally short right leg. This can occur in a patient with an otherwise normal pelvis and is probably due to right motor dominance combined with left vestibular dominance. In other words when you have a right-handed person with a short left leg—the muscular component overrides the anatomic. In these cases the short left leg is probably either congenital or secondary to trauma. On other occasions you will find a normal pelvis radiographically, i.e. level sacral base and equal leg lengths, and the patient will display a functional short right leg. This again shows muscular dominance and is typical for right-handed (CCP) people. The main reason for the exceptions is either fixed scoliosis or a cranial asymmetry (usually lost vertical dimension on one side of the bite)."

The "key phrase for me was: "The ilium on the "functionally" short side is anteriorly rotated which places the femoral head in a more *cephalad position in an off-weighted position.*" Although this was precisely the picture I had in my mind concerning the positioning of the femoral head and acetabulum, I was unable to verify these findings using palpatory evaluationsÖI simply had to see it!

WORKING FROM AN ASSESSMENT BASELINE

One assessment protocol I have found helpful when performing pain management structural work is to first develop a *baseline of aberration.* Working from a baseline simply means that I strive to view the body as a whole while maintaining certain expectations of what patterns I am inclined to see. For example, I ask myself:

- What predictable structural patterns are represented;
- Which alternate patterns typically accompany the aberration I am seeing;
- Is there a "key" neuromyoskeletal disorder triggering the primary dysfunction;
- Am I seeing an upper or lower crossed or common compensatory pattern, and
- What fascial, skeletal, or diaphragmatic tissue is responsible for their primary decompensation?

With all the new research surfacing on predictable patterns, it is now possible to begin combining various formulas to help develop a clearer picture of common postural asymmetries. This synergy greatly enhances visual and hands-on evaluations.

SEARCHING FOR THE "TIE THAT BINDS"

Based on research from innovators such as Janda, Rolf, Zink, Greenman, Mitchell, Previc, Pope, and others, I often begin my visual and hands-on analysis with a preconceived notion of certain predictable muscle/joint strain patterns and then record non-adapting or compensating patterns. I find this approach more interesting, less confusing and more practical than myopically investigating a single area and then attempting to relate it to the rest of the structure. Although the process demands an open mind and heart, it is still exciting to search for early embryologic clues and find where the client either follows or departs from the norm. When clients come in hurting, I always ask myself: "What key dysfunction is driving this aberrant posturally-initiated pain pattern and does the root cause of this disorder seem to be based in genetic influences, early embryologic development, trauma, habitual patterns, gravitational exposure, psychosocial, or vestibular/motor dominance?"

Unless I am dealing with acute injuries, such as tennis elbow, ankle or knee sprains, etc., I typically observe for common dysfunctional postural patterns (upper and lower crossed, common compensatory) rather than myopically evaluate each body segment. Sometimes it works; and other times I simply get lost in all the overlapping embedded aberrant strain patterns. At this point, I begin at square one and untangle the mess until familiar patterns begin to emerge.

BACK TO THE BASICS... SHORT RIGHT LEG

Limb length discrepancy is simply defined as a condition where one leg is shorter than the other. When a substantial difference exists, disruptive effects on gait and posture can occur.

As discussed earlier, leg length discrepancy can be divided into two etiological groups;

1. Structural: True shortening of the skeleton from congenital, traumatic, or diseased origins.

2. Functional: Develops as a result of altered

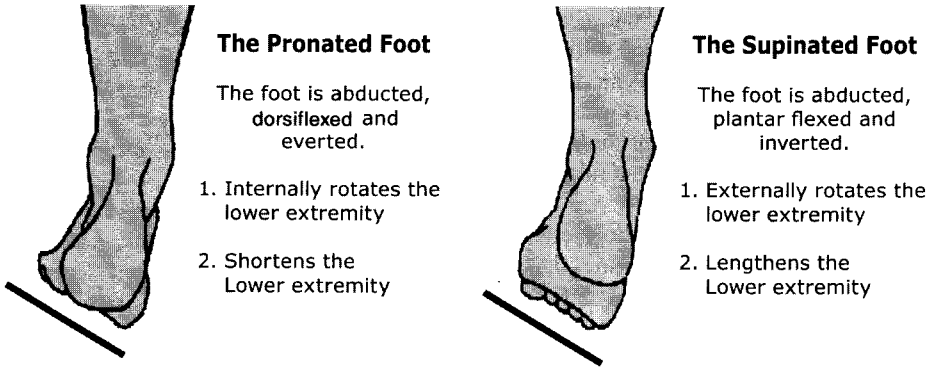


Fig. 11. Rigid, Supinated and Hyperpronated Flat Foot.
As specialized receptors inform the brain of pelvic imbalance, signals are sent to supinate the foot on the short leg side in an attempt to lift and balance the anterior/inferior rotated ilium. Regrettably, prolonged supination strains the myofascia and metatarsals due to excessive weight-bearing on the lateral arch. The brains attempt to lift the ilium often cause the foot to function in an equinus position to prevent dorsiflexion. The opposite pattern typically occurs on the long-leg side causing hyperpronation or flattening of the medial arch to lower the high ilium. If the antigravity (springing) function of the left foot is lost, the dropped arch becomes a precursor to foot/hip/knee and back pain.

mechanics of the lower extremities (foot hyperpronation) or pelvic obliquity due to upper quadrant muscle imbalances such as tonic neck reflexes, poor trunk stabilization, protective lumbar muscle guarding, deep fascial strain patterns, etc.

For efficient locomotion, a symmetrical and well aligned body is necessary. If symmetry is distorted, particular by limb length discrepancies, then gait and posture are disrupted. Consequently, a diversity of symptoms can prevail, and without adequate treatment, often manifests as chronic sources of pain and dysfunction.

THE BODY'S INNATE COMPENSATORY CAPABILITY

Simply stated, innate compensations occur to lengthen the short leg and to shorten the long leg. Typically, the body's innate wisdom immediately begins correcting the limb length strain pattern with information gleaned from proprioceptors on the bottom of the feet and a little help from friendly hands. Millions of these receptors sense weight imbalance and body sway (Fig. 10). It is intriguing to watch as the foot on the short leg side raises the medial arch (supination) in an attempt to balance the anterior/inferior rotated innominate. Regrettably, prolonged supination strains the myofascia and metatarsals due to excessive weight-bearing on the lateral arch. The brains attempt to lift the ilium often causes the foot to function in an equinus position to prevent dorsiflexion.

The opposite pattern typically occurs on the long-leg side as the brain hyperpronates or flattens the medial arch to lower the high ilium. This not only is a precursor to foot pain but also encourages medial wear of the shoe.

As a result of these foot compensations, the shorter leg may be prone to stress fractures due to the non-shock absorbing nature of the supinated foot (Fig. 11). Likewise, hyperpronation of the long leg may cause medial knee pain as the tibia internally rotates.

In the lower limbs, compensations at each level can be summarized as follows;

- Ankle instability due to foot supination on the short side;
- Knee hyperextension on the short side and the knee flexed on the long side;
- Externally rotated leg on the short side, and
- Circumduction of the long limb.

TRUNK AND HEAD COMPENSATIONS

Compensatory scoliosis is commonly reflected as a low shoulder on the high ilium side. Since the head typically will not tilt to maintain the eyes parallel to the horizon, a short 'C' curve is common in the cervical vertebrae. Elbow and hand positions may appear shorter on the shorter leg side, with the opposing arm swinging more on the shorter leg side.

Some authors suggest that there is a rotation of the pelvis towards the long leg side, possibly due to hyperpronation and medial leg rotation 5. They describe a typical gait where the short leg steps down and the long leg compensates by "vaulting" Walking on toes on the short side and flexing the knee of the long side seems to be a fairly consistent compensatory gait.

The center of gravity is shifted unevenly, so the smooth sinusoidal motion of gait is disrupted. Thus the cosmetic effect of the gait can also contribute to the compensation mechanisms. For example walking on the toes may lead to a contracture of the Achilles and calf muscles leading to conditions such as Achilles tendinitis and plantar fasciitis.

Other muscle compensations include shortening of the quadratus lumborum on the long side, and a shortening of scalene, levator scapulae, sternocleidomastoid, and upper trapezius muscles on one side to maintain the head in an erect position and the eyes level. Compensatory muscle shortening can also lead to joint compression and muscle guarding.

That Hitch in your Get-Along

The presence of a limb length discrepancy is usually easily recognizable during gait by observing for:

- Shoulder tilting to one side;
- Unequal arm swing;
- Pelvic tilt;
- Foot supinated on the short side and pronated on the long side;
- Ankle plantarflexed on the short side, and
- Knee flexed on the long side.

Note: During running, it has been suggested that limb length discrepancy makes no real difference due to the fact that only one foot strikes the ground at any given time. However, Blustein and D'Amico's extensive research finds that leg length discrepancy is *the third most common cause of running injuries*[6].

POSTURE AND LIMB LENGTH DISCREPANCY

The most common postural compensation for leg length discrepancy is a functional scoliosis. Scoliotic patterns that remain in both standing and flexion indicate a structural or fixed scoliosis (Fig. 12).

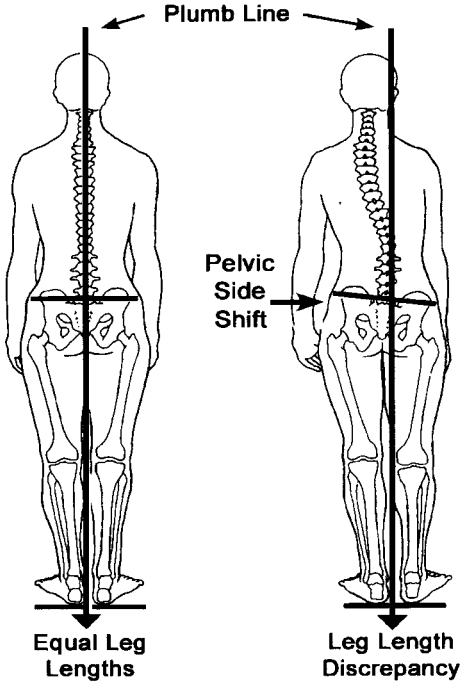


Fig. 12. Short Right Leg Sideshifts the Pelvis, Resulting in Compensatory Scoliosis. The most common postural compensation for leg length discrepancy is a functional scoliosis. A general rule has been suggested which summarizes the type of scoliosis present in relation to the limb length discrepancy. If the leg length discrepancy is less than 1cm, a 'C' curve will be present with the shoulder on the short side being the higher of the two. Conversely, an 'S' curve will be observed if the limb length discrepancy is more than 1cm. This increased leg length inequality causes the shoulder on the shorter side to appear lower. Typically, the pelvis will be more inferior on the short side and the thoracic spine will have a type I group curve convex left with the shoulder and arm hanging lower on the long leg side (left).

A general rule has been suggested which summarizes the type of scoliosis present in relation to the limb length discrepancy. If the leg length discrepancy is less than 1cm, a 'C' curve will be present with the shoulder on the short side being the higher of the two. Conversely, an 'S' curve will be observed if the limb length discrepancy is more than 1cm. With this increased leg length distortion, the shoulder on the shorter side should appear lower 7.

Typically, the pelvis will be more inferior on the short side and the thoracic spine will have a type I group curve convex left with the shoulder and arm hanging lower on the long leg side (left).

CONCLUSION

The importance of limb length discrepancy cannot be ignored, and is often the key feature in lower limb and back pathologies. Thus the proper visual and anatomic client evaluations are paramount in determining a functional from a structural limb length discrepancy. Always refer to manual medicine physicians for a radiographic screening if in doubt about your ability to adequately and consistently distinguish leg length discrepancies.

Proper limb measurement is essential; unfortunately there is no single hands-on method that proves to be completely reliable in its own right. It is for this reason that following a holistic approach that includes systematically eliminating aberrant strain patterns, correcting aberrant firing order patterns and searching for embryologic clues to key posturally-initiated pain issues may boost your success and empower your practice.

Of course, measuring the limbs in conjunction with gait and posture analysis is vital. The compensations which are part of limb length discrepancy have been discussed. Although presentations do differ from client to client, most of the patterning theories presented will prove accurate. The most important feature for the beginning therapist to recognize is that asymmetry existsÖfrom there more specific details will emerge with experience.

Integral parts to treatment of the condition are identification, comprehension of each individual's compensatory adaptations and their relationship to resultant symptomatology. Today's therapist must be aware of the fundamental importance of limb inequalities—particularly the short right leg phenomenon. Keep an open mind, look for structural relationships, and have fun when assessing and treating asymmetrical leg length patterns and resulting compensations.

REFERENCES

1. Garson JG. Inequality in length of lower limbs. *Journal of Anatomical Physiology*. 1897. pp 502-507

2. Hasse C, Dehner, Arch. Etiology and Pathophysiology of Leg Length Discrepancies. *Anatomical Entwickl*. 1893

3. Denslow J, Chase I, et al. Mechanical stresses in the human lumbar spine and pelvis. 1962. In: Postural Balance and Imbalance. Peterson B, ed. Indianapolis: *American Academy of Osteopathy*, pp. 76-82, 1983.

4. Juhl J, Prevalence of Frontal Plane Pelvic Postural Asymmetry,

Journal of the American Osteopathic Association, Volume 104. 2004

5. Blake, R.L. and Ferguson, H. (1992) Limb length discrepancy. *JAPMA* 82 (1) pp 33-38.

6. Blustein, S.M. and D'Amico, J.C. (1985). Limb length discrepancy: identification, clinical significance and management. *JAPMA* 75(4) pp200-206.

7. Chambers, M.R.C. (1996). Limb length inequality: types, etiologies, pathomechanics, values and incidence. *Journal of British Podiatry* Medicine 51(5) pp74-80. ❑

To order *Advanced Myoskeletal Techniques*® and other manual therapy products, please call the Freedom From Pain Institute® at 1-800-709-5054.
For on-line orders visit:
www.FreedomFromPainInstitute.com