Scoliosis: Assessment and Treatment

By Jeffrey Burch, Certifed Advanced Rolfer™

Jeffrey Burch

ABSTRACT *This comprehensive article begins by describing scoliosis from several perspectives, and then addresses how we as structural integration practitioners can work with scoliosis, both in our own practices and through teamwork with other practitioners.*

PART I: ABOUT SCOLIOSIS

All scolioses share certain characteristics, and each scoliosis has a unique combination of other features. All snowflakes are recognizable as snowflakes and no two have ever been found to be identical. So it is with scoliosis.

Commonalities in Scoliosis

First, the common ground.

All scolioses are sidebending (frontal plane) curves of the spine that can neither actively nor passively be brought to a straight vertical axis. All of our spines should be able to bend to either side. Any fixation in sidebending is called scoliosis. To begin to quantify this, at least four adjacent segments must be sidebent the same direction for the spine to be described as having a scoliosis.

Sidebending and rotation are always coupled. In the mechanics of our spine, neither sidebending in a frontal plane nor rotation around a vertical axis can occur alone. In other words when one is present, the other will also always be present. In the thorax, the rotation moves the spinous processes to the concave side of the sidebending curve, unless there is a large degree of flexion or extension also present. One effect of this is that, for a mild scoliosis, the line of the tips of spinous processes may appear straight when the person is standing, even though the bodies of the vertebrae are arranged in a curve.

Theme and Variations in Scoliosis

That's it for the common characteristics. Now for the snowflake patterns. We can describe features of each scoliosis from several perspectives, akin to describing color in terms of hue, value, and chroma, or plant identification by size, form, leaf shape, flower color, and odor.

Scoliotic characterizations require that we investigate:

- etiology (if known) of the scoliosis; 'idiopathic' if unknown
- age at first diagnosis
- number of curves
- direction of each curve
- depth of each curve
- correlation with genetic syndromes

Each of these features is looked at separately, and then the information brought together to form a fuller picture of that person's scoliosis.

Etiology

An important point to remember is the likelihood of multicausality. There is a classic thinking error in which something related to a problem is found, leading the investigator to believe the whole story has been told, thus ending the investigation. The fact first recognized is seldom the entire explanation, and may not even be one of the more important pieces of the puzzle. However much we learn about a problem, we must always keep looking.

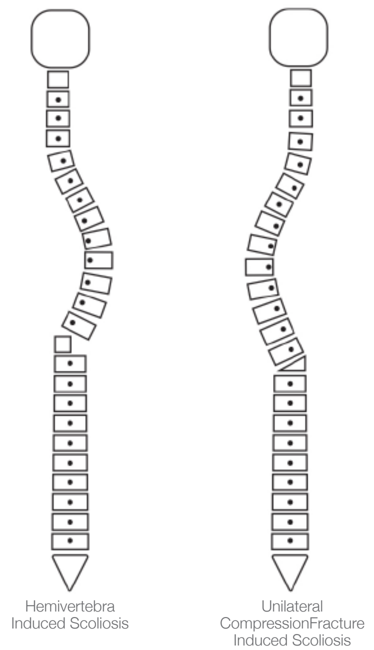

Figure 1: Scoliosis induced by a hemivertebra (left) and by a unilateral compression fracture (right).

Unilateral compression fracture: The body of a vertebra may be shattered in an injury. If the full width of the body of the vertebra shatters, that vertebral body will lose height resulting in an angulated kyphosis at that level. If only one half of the vertebra – left or right – is shattered, the spine above that level will tilt to that side, producing an angulated scoliosis similar to a hemivertebra, with similar compensatory patterns (see Figure 1). Such fractures are usually produced by a near axial load such as a fall landing on either the ischial tuberosities or the feet. This often shatters a single level in the spine, but may shatter two or more vertebrae.

Congenital hemiblock vertebrae: A block vertebra is a congenital fusion of two or more adjacent segments in the spine. Usually hemivertebrae are fused full-width. However, it is possible for the fusion to be only one side – left or right. When only one side is fused, during childhood growth the fused side is not able to grow vertically as much as the unfused side, and a scoliosis will progressively develop.

Degenerative scoliosis: Any combination of unilateral disc degeneration, asymmetric facet-joint degeneration, asymmetric osteoarthritis, or osteoporosis can result in marked loss of height on one side, left or right, of a portion of the spine. This is a condition most common in people over age forty. Sedentary lifestyle plays a major role. Occupations that make markedly asymmetric use of the body can contribute. Poor diet and genetics also make contributions.

Neurologic: Scoliosis can be caused by neurologic deficits, which create an asymmetric ability to recruit muscles, and/or long-term asymmetrical muscle spasms. Sources of this include:

- stroke
- brain tumor affecting motor control
- brain surgery affecting motor control
- asymmetric peripheral nerve damage
- cerebral palsy
- Duchenne muscular dystrophy
- ALS

Infectious disease: Some infectious diseases directly affect bones. These include osteomyelitis and tuberculosis of the spine. Osteomyelitis is an infection of the bone, a descriptor that is non-specific as to infectious agent. However, the infectious agents are usually bacterial. Bone infection anywhere in the body is life-threatening and requires prompt robust antibiotic treatment. The infection weakens bone and when present in the spine can result in scoliosis. Tuberculosis of the spine is a particular infection in vertebrae by *Mycobacterium tuberculosis.* Tuberculosis is usually thought of as a lung infection, but the bacteria can infect any body tissue. Bone tuberculosis is fairly common. It is worth noting that pulmonary tuberculosis, as well as other severe pulmonary infections, are known to contribute to scoliosis by creating asymmetric pleural adhesions that bend the spine. More on this below.

Anatomic leg-length difference: This is objectively measurable length differences between the left and right long bones of the legs. It is best measured as a standing x-ray as supine measurements are less accurate. (This must not be confused with functional leg-length difference, which is determined by comparing the way medial malleoli meet in a supine position. Functional leg length differences are entirely soft-tissue problems and do not affect the relative height of the greater trochanters when standing.) If one leg is anatomically substantially longer than the other, the pelvis – including the sacral base – will be tilted toward the short-leg side. The fifth lumbar vertebra, articulating with the sacrum, will be tilted to the same side as the anatomically short leg. Vertebrae superior to that will incrementally correct toward level. For moderate anatomic leg-length differences, the lateral curve may be entirely in the lumbar spine. For greater leg-length differences, there may be a compensatory curve or curves in the thorax, or rarely a single curve through the whole spine. See Figure 2. Some persons are born with anatomic leg-length

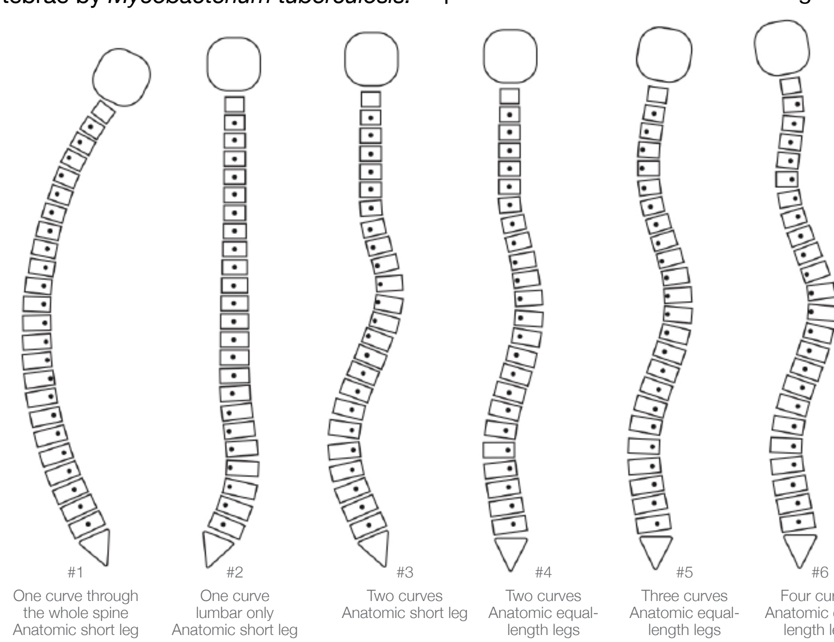

Figure 2: Varying numbers of scoliotic curves, and patterns related (or not) to an anatomic leg-length difference.

differences; others spontaneously develop during growth; and some are created by fracture management or surgery.

Idiopathic

The above seven categories distinguish scolioses by known origin. Collectively, these seven categories describe a minority of cases of scoliosis. The etiology of the majority of scolioses remains unknown. These scolioses of unknown origin are called 'idiopathic', a medical term that means "We don't know where it came from."

With idiopathic scoliosis, the sidebending of the spine is initially a soft-tissue problem – tight tissues pulling bones out of line. Over time, the unbalanced forces on the bones induce the bones to change their contour. For a typical idiopathic scoliosis diagnosed between ages nine and fourteen, there is initially no bony deformity. By that person's late twenties, there will be body deformity as the bones adapt to their positions. This speaks to the value of our early intervention.

I have a speculation related to some idiopathic scolioses. Identical twins are formed when one embryo divides very early in development into two genetically identical babies. Fraternal twin formation occurs when two ova are released, both are fertilized, and both survive until birth. Fraternal twins are as like and unlike each other as any other two siblings. There is another less-known phenomenon in which two fraternal twin embryos merge into a single baby. This is called *chimera*, or *mosaic*. In a mosaic, the components of the two embryos may be well-mixed or not. With less well-mixed chimeras, a person may have checkerboard skin color, eyes of two colors, marked facial asymmetry, or other obvious dissimilarities. Other times, the mix is more homogenous so there is nothing to see on the surface.

While *chimerism* or *mosaicism* has been recognized for a long time, incidence of it has not been measured. Clinicians and researchers suspect that there are many more human chimeras than we have been aware of. The incidence of human chimerism has been challenging to quantify: the two cell types may have any distribution and proportion in the body, so identifying a mosaic would require sampling many tissues in the person, some of them quite deep. One opportunity to measure comes in studying people with Down's syndrome, as these patients are often screened by examining their blood cells to see what proportion of the cells have trisomy 21. The etiology of Downs syndrome is the presence of a complete or partial third chromosome number 21. While about half of Down's syndrome patients show mosaicism, the proportion of the two cell types is highly variable, reflecting non-equal mosaicism. This, however, looks only at mosaic distribution in marrow, the tissue that creates blood cells. Mosaicism could be expressed entirely in other tissues. Recently, researchers used embryos from in vitro fertilization to investigate this further. For in vitro fertilization, several embryos are fertilized; typically two are implanted and the rest discarded. In the study, the extra embryos were analyzed cell-by-cell for mosaicism. This is practical since each early embryo has only a small number of cells. The results showed that 50% of these embryos were mosaics. It appears half of us have two distinct genotypes. My guess is that idiopathic scoliosis is more common in those who are mosaics. Another hypothesis is that autoimmune disorders are more common among mosaics.

Categorization Based on Age of Onset

Birth: Some scolioses are present at birth. Etiology may be hemivertebra, unilateral block vertebra, or – most commonly – idiopathic. The idiopathic ones sometimes resolve during childhood growth, sometimes not.

Early childhood: Some scolioses first appear at a young age. These can involve injury, neurologic insult including cerebral palsy, other brain injury, or peripheral nerve injury. The majority are idiopathic. The idiopathic ones sometimes resolve during childhood growth, sometimes not.

Later childhood and adolescence: Of idiopathic scolioses, 80% are in girls, and most commonly appear during the growth spurt associated with puberty. While scoliosis in boys is less common, it tends to occur at a somewhat earlier age, around nine to ten. Scoliosis of other etiologies can occur in this same age range, including bony injury to the spine or legs, neurologic insult, or vertebral infections.

Young adulthood: The onset of idiopathic scoliosis is over by physical maturity, which may be between ages seventeen and twenty-two. Injury and infection are the opportunities in young adulthood, and this is the least common era for the onset of scoliosis.

Midlife: Past age forty, the likelihood of degenerative scoliosis gradually increases. Injury and infection-induced scolioses continue to take small tolls.

Old age: The trends of midlife continue to accumulate into senescence.

Number of Curves

One curve: It is possible for a scoliosis to have only one curve with no compensatory curves (Figure 2, #1 and #2). There are two versions of this. With a mild-to-moderate anatomic leg-length difference, there can be a lumbar scoliosis with no thoracic compensation. More rarely there is a single curve to the same side through all areas of the spine from skull to sacrum.

Two curves: Most commonly there will be a curve to one side and a compensatory curve to the opposite side (Figure 2, #3 and #4).

Three curves: Slightly less commonly, there will be a series of three curves (Figure 2, #5), one to one side, another above that to the other side, and a third, more superior, back to the side of the most inferior curve.

Four curves: Uncommonly, the pattern described for three curves will be extended to four curves (Figure 2, #6); for example, from inferior to superior, left-right-left-right, or right-left-right-left.

Direction of Curves and Primacy Among Curves

Scoliosis curve directions are named for their convex sides. In the normal mechanics of the lumbar and thoracic spine, the spinous processes rotate to the hollow side of the curve, which means the bodies of the vertebrae rotate to the convex or bulging side of the curve. If the bulging side of the curve is on the right, the bodies of the vertebrae rotate to the right and this is called a *dextrorotary curve*. ('Dextra' refers to right and 'levo' to left.) If there is a single curve it is named for its convex side. If there are two curves in opposite directions, each curve is named for its convex side, however one curve is considered to be the 'primary' curve and the scoliosis as a whole is named for this 'primary' curve. When two or more curves are present, the criteria for deciding which of them is primary are ill-defined. There is an assumption that the primary curve occurred first, although it is rarely possible to know this historical sequence as fact. The primary curve is usually the longest curve, which means it is almost always the curve in the thorax. About eighty percent of scolioses have a thoracic (primary) dextrorotary curve, ie, convex on the right.

Depth or Radius of Curve

The depth of the curve can be measured. This is usually done by drawing a series of straight lines on an x-ray by a method known as the Cobb angle method (see Figure 3). The top and bottom laterally-tilted vertebrae in each curve are chosen, and a line is drawn extending the superior or inferior surface of each of those vertebrae. Where those lines intersect is called the Cobb angle. Measurement of the Cobb angle quantifies the curve and 10˚ is the minimum standard to define a scoliosis. Thoracic curves greater than 60˚ have been shown to result in severe cardiac and pulmonary compromise. Cardiac compromise tends to be greater with thoracic curves convex on the right, which compress the heart on the left side of the chest.

Correlation with Genetic Syndromes

Some genetically-based syndromes have elevated incidence of scoliosis: Marfan syndrome, Ehlers-Danlos syndrome, Trisomy 21/Prader-Willi syndrome; Beals syndrome, and spina bifida. Spina bifida may have a purely nutritional component if there is severe vitamin B12 deprivation during pregnancy. Often spina bifida is largely an expression of Methylenetetrahydrofolate reductase (MTHFR) gene mutation; the MTHFR enzyme converts folic acid to methyl folate, the active form in our physiology.

Multicausal

As mentioned above, a scoliosis may have more than one contributing factor. For example, a client may have a mild anatomic leg length difference, a highly asymmetric occupational or recreational activity (such as a baseball pitcher), and an injury (such as a unilateral compression fracture). Or, another example, the person may have Ehlers-Danlos syndrome, spina bifida occulta, a sedentary occupation (such as seated work requiring frequent rotation to one side only), and a small stroke that affects muscle control.

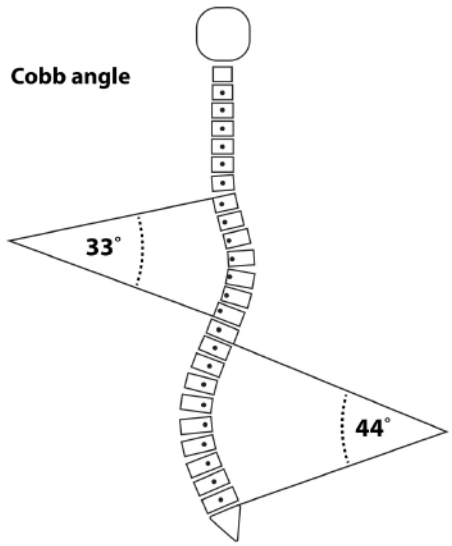

Figure 3: Measurement of the Cobb angle.

PART II: TREATMENT OF SCOLIOSIS

Below I will discuss how to approach scoliosis with Rolfing® Structural Integration (SI), as well as the importance of teamwork with practitioners of other modalities.

Know Your Client's Scoliosis

A client telling you s/he has scoliosis is a useful start, but insufficient. Collect more information.

History: First, take a history. Here are useful questions:

- When was it first observed?
- Who found it, and how?
- Have any x-rays or MRIs been taken? When? What did they show? Are these films and radiology reports available?
- How have other healthcare providers described this scoliosis?
- What treatment has been tried in the past? With what results?
- What other treatment is ongoing now?
- Has any anatomic leg-length difference been verified by standing x-ray??
- Was there any precipitating event: injury, Illness, period of unusual activity.
- Do any first-degree relatives (parents, siblings, children) have scoliosis?
- What other syndromes are present?
- What are and have been the person's occupational and recreational activities?

Request x-rays and medical reports: Ask the above questions and remember that most people are weak medical historians. Request records. Request the x-rays, associated radiology reports, and related medical reports. If the last x-ray was more than five years ago, suggest the client discuss with his/her doctor the potential value of getting a current x-ray. A lot can change in five years.

Quick test: A quick and informative test for scoliosis uses the fact that the coupling between rotation and sidebending in the spine also interacts with flexion. Sidebending and rotation cannot occur separately, but if the spine is also flexed, more of this coupled motion is put into rotation, and the bodies of the vertebrae may rotate in the opposite direction. Have the client comfortably seated with his/her feet on the ground a little in front of the knees, arms hanging loosely at his/her sides. Ask the client to roll down – similar to a roll down for SI back work. As the person rolls down, notice, in passing, areas of reduced mobility. The real test for scoliosis is when the client is fully forward bent. Because the flexion of the spine shifts the rotation/sidebending coupling to more rotation, the scoliosis will be much more visible in this flexed position. The ribs on the convex side will be much more prominent toward the ceiling. The degree of this prominence gives you a rough estimate of the degree of scoliosis.

Ask about other treatment: Ask the client what other treatment s/he is currently receiving related to the scoliosis. Ask the client what treatment s/he has had in the past, including – but not limited to – surgery and physical therapy.

Consult: Talk to the client's physical therapist, occupational therapist, Pilates teacher, Schroth Method teacher (more on that below), etc., to coordinate care.

Some Specific Situations

Hemivertebrae: This is a difficult structural situation. The medical solution is to remove the hemivertebra and fuse the adjacent segments, which provides straightness and stability. It is a sensible solution to an otherwise unmanageable situation. The surgery must be done by adolescence, though earlier is generally better. After recovery from surgery, SI can offer a great deal to help the client adapt to his/her modified body.

Compression fracture: The surgical solution to a compression fracture is a *balloon kyphoplasty*. A balloon is inserted into the crushed bone and carefully inflated to restore the height of the vertebral body. The balloon is then withdrawn and the space created is filled with cement. This restores the height and shape of the vertebra. Once the bone is well healed, SI can help the client adapt. If the vertebral body was allowed to heal without this balloon intervention, it will have healed in an angulated, sidebent position that is very difficult to manage. Some compensations may be addressed and mobility may be improved, but it will not be possible to straighten this spinal segment.

Significant anatomic leg-length difference: How much leg-length difference a person can tolerate and adapt to varies with several factors including, prominently, disk health and occupational and recreational stressors. Often people adapt to a half-inch of anatomical leg-length difference without symptoms. For larger or otherwise symptomatic differences, shoe lifts are in order. Heel lifts have been used, but these have the disadvantage of pitching weight forward onto the ball of the foot; a one-inch heel height doubles the load at the metatarsal heads. That is why it is often better to lift the foot as a whole. There are additional considerations with this. The added sole height makes the sole of the modified shoe both heavier and stiffer. The stiffness is an unfortunate side effect. Choice of sole material can partially mitigate this. Some prosthetists add weight to the non-lifted shoe to equalize the inertial mass. Both shoes are now heavy, which changes gait, but this may be a lesser evil than a large difference in shoe weight between the two feet.

Neurologic problems: If the scoliosis is of neurologic origin or has a substantial neurologic pathology contribution, it is important for the client to work with a physical therapist well-versed in this kind of situation. Therapy must be focused on evoking as much potential from the person's nervous system and musculature as possible. Sometimes much can be done; other times very little. Anne Shumway-Cook and Marjorie H. Woolacott (2017) have written an excellent book – *Motor Contol: Translating Research into Clinical Practice*, a comprehensive presentation of research in the field geared to clinical intervention – and also offer workshops in their methods.

SI for Scoliosis

The Place of the Ten Series

In my Advanced Training in 1990, Jan Sultan told us that while he regularly uses the Ten Series, he will often do several sessions of non-formulaic work before beginning the series. He likened this to wanting to cook a nice meal, but the kitchen is a mess, so it is necessary to clean the kitchen first. This way of thinking is strongly applicable to scoliosis.

With scoliosis, the kitchen is always very messy. It's important to attend to disorganization as you discover it. For this reason, the process will involve considerably more than ten sessions. Begin by cleaning the kitchen as well as possible. Work with what you find. Think structurally. Apply the principles of Rolfing SI in a broad context. The work will be more like sessions eight and nine. Do not chase pain. During the Ten Series, you may open a cabinet or drawer in the kitchen and find another mess. Pause the 'Recipe' to deep-clean that mess.

There are innumerable possible ways a 'kitchen' can be dirty. Often, a client will show more than one. For example, shoulder girdles and upper limbs often compensate for scoliosis. The central goal of improving breath in a First Hour may not be directly approachable. It might be necessary to increase the organization of the client's hands before any improvement can be made in breath. The series dictates that we work first on superficial layers before proceeding deeper, like peeling an onion. However, if the surface of the body appears lax and deep tissues are stiff and condensed, then working on deeper layers first to expand them will take up slack in surface layers so the tonal differences between portions of the 'sleeve' become visible. 'Cleaning the kitchen' is a big job in itself.

When you do use the Ten Series with scoliosis clients, stay with a goals-oriented version of the Recipe rather than an anatomic-territory version. On several occasions, when Dr. Rolf was demonstrating a First Hour on a new model, she used that opportunity to work on the feet and lower legs. She was not skipping ahead to the Second Hour. A central goal of the First Hour is to do what is immediately available to improve the person's breathing. In those First Hours she could see the clients' contact with the ground was so poor they could not relax into their base of support, which limited their breath. The best thing she could do for their breath at that moment was to give them a better base of support. Similarly, a central goal of a Second Hour is to get the feet more fully and flexibly on the ground. Accomplishing this may or may not include touching the feet. The problem may come primarily from higher up.

Application of Rolfing SI Principles of Intervention

A further consideration is the application of the Principles of Intervention that underlie Rolfing SI. Get support under the spine by first organizing feet, legs, and pelvis. Organize the ends of spine, neck, and head. Follow Rolf's classic Recipe, which has as one of the goals of every session to horizontalize and mobilize the pelvis. Keep at all of this. Sorting out the ends of the spine and improving the client's base of support will make it easier to change the spine. Every time you change the spine you will put more demand on the ends of the system and you will have to help them adapt more. Every hour is an integration hour. Only following the Recipe won't work well. You need to work in a more circular way, like scoilosis itself, revisiting the same areas multiple times in order to achieve better organization.

Order of Intervention

In my Basic Training we were repeatedly told that the perpetual question in our minds must be "Where can I work on this person at this moment that will make the greatest change for the whole person?" It was a great idea, but we were not given many tools to figure out where that sweet spot was. Decades later, in my first Barral Institute class, I was told exactly the same thing, and given a group of assessment methods to find the place on the body that would make the most change for the whole person. The instructor also offered language for this 'best' spot, calling it the 'primary restriction'. *Primary* in this context meant it was what should be worked on first, and had nothing to do with either the order in which restrictions were created or the severity of the restriction.

A central assessment method to find the primary restriction, popularized by Barral and his associates, is called by the non-descriptive term 'general listening'. (Instructions for general listening are in Appendix 1.) One effect of working on the primary restriction is to 'shuffle the deck'. Once the primary restriction is worked on, it is necessary to have the client stand and 'general listen' again to learn what has become the *next* primary restriction.

Myofascial Factors

Myofascial factors contributing to scoliosis include:

- ligamentous laxity
- ligament fibrosity
- muscle weakness
- muscle fibrosity
- muscle spasticity
- fibrosity in other tissues

Ligamentous laxity (or weakness) allows bones to fall out of line. Fibrosities both pull and hold bones out of line. While both can be found in scoliosis, the fibrotic problems are by far the more common. These fibroses can be viewed as restricting factors preventing the spine from moving from sidebent to straight. The fibroses may be local, close to the curve, or at any distance in the connective-tissue matrix of the body. The situation is never simple. There are always multiple fibrosed areas – some local, some at a distance – holding the spine out of line.

There is a straightforward process to finding a succession of fibrosities maintaining the curve, a process I developed called Ultra-Slow Mobility Testing (USMT). The general form of this method is included as Appendix 2, which I recommend reading now, in service of understanding the principles of treatment, before proceeding with this article.

To apply USMT to a scoliosis, choose the particular curve you want to treat at the moment, then follow these steps.

1. Position the person's body deeper into the curve, as deep into the curve as can be achieved without undue effort and while maintaining comfort for the client.
2. Pause for a moment.
3. Instruct the client not to help.
4. With your hands, begin to straighten the curve with almost imperceptible slowness. As you use your hands to straighten the curve, also keep your hands actively sensing. At the first hint of increased resistance, feel for the 'catch' or 'bind' that resists your movement. This may be close to the curve you are testing, or far away in the body. Allow yourself to be surprised.
5. Work the area that 'catches' or 'binds' with the goal of increasing tissue span, using any of the soft-tissue methods we have to increase the length and elasticity of tissue.
6. Once that area is worked, return to Step 1. Repeat this cycle several times, maintaining an approach of curiosity and willingness to be surprised.

In this process, myofascia may be worth working on – and myofascia is commonly the least useful tissue. Many tissues can be fibrosed. In Rolfing Basic Training, there is focus on connective tissue associated with muscles, yet this is the connective tissue in the body least likely to be 'primary' among restrictions to work with. Skin, organ support membranes, vasculature, nerves, meninges, and bone are more likely to be primary. When the primary restrictions are found and released, the compensatory holdings in muscle and myofascia will fade away, as they are now no longer useful. Consider instead working with:

- organ support membranes and organ glide planes (dura, pleura, peritoneum)
- nerves
- vasculature
- strain in bone

USMT may be applied to any shortened area. Lengthening is the objective. For scoliosis, an obvious application of USMT is to find a series of shortened tissues maintaining an alignment distortion and/or mobility limitation. Also consider the rotary component of scoliosis. A way to do this is to have the client seated. Ask the client to allow you to move his/her body slowly, with the client neither helping nor resisting. With your hands, contact the upper thorax (not shoulder girdle); rotate the client to the left to an end of range of motion. Allow the client to return to neutral by slowly reducing the load applied to rotate the body. I allow it to spring back toward neutral. Then pause briefly. Rotate the client to the right, again to 'end-feel'. Notice which side is more mobile.

After returning to neutral and pushing again, rotate the client to the more mobile side. Next, *very* slowly (like grass growing!) reduce the force you are using to hold the client in rotation. Watch for the first hint of a catch, which will occur well before neutral. Note the location of the catch. Allow the client to return fully to neutral. When the client rotates to one side, this loads tissues in the body, like springs. By gradually reducing the rotary force, the body will slowly spring back toward neutral. This may be done in a seated, standing, or lying-down position. (Use any method we have for lengthening and increasing the elasticity of soft tissue.)

After the first catch is treated, return the client to seated position and repeat the rotation test on both sides to see what, if any, improvement has been made. If rotation to the two sides is not equal (which, after one intervention, it usually will not be), repeat the test sequence to find and treat the next catch. Repeat this sequence until rotation to the two sides is substantially closer to equal and full.

A Trick of the Trade

We SI practitioners give considerable emphasis to the iliopsoas muscles. Rightly so, as the psoas major is a crucial determinant of the depth of lumbar curve and degree of lumbar rotation. The iliacus is similarly a major player in anterior or posterior tilt of the ilia. There are many things that can happen to these muscles. In my experience, the single most common issue is reduced glide of the iliopsoas over the front of the pelvis and the femoral neck. I have never seen a new client who had this glide working well on both sides; often it is not working well on either side.

This issue is widely recognized in osteopathy. I was taught the following protocol by three different osteopaths all of different lineages. The iliopsoas is accompanied by the femoral artery, femoral vein, and femoral nerve. Collectively, these four structures are known as the *inguinal bundle.* Any or all elements of this bundle can and frequently do have reduced glide under the inguinal ligament.

To assess this glide, have the client lie supine. Locate the inguinal ligament and make a dynamic stabilization of it with one hand. With the other hand locate the inguinal bundle just inferior to the inguinal ligament. With a respectful gentle load, try to glide the bundle inferiorly under the ligament. Note the excursion of the bundle under the ligament. Rearrange your hands to again make a dynamic stabilization of the ligament and to contact the inguinal bundle just superior to the ligament. Now gently attempt to glide the bundle superiorly under the ligament. If the inguinal bundle is found not to glide well, work gently to restore this glide; you are working with major blood vessels and a major nerve so always be gentle. A way to restore glide is to turn the test procedure into a treatment. Try to glide the inguinal bundle superiorly; as you approach a soft barrier to this glide, pause and maintain the traction. This puts a gentle shearing force through adhesions in this area. After a few moments, reverse your hands and apply the same sort of traction inferiorly. Continue to work in an alternating superior-and-inferior manner, traction load-shearing, until the glide improves.

Assembling Your Team

Treatment for scoliosis is usually a team effort. Depending on the characteristics of the particular scoliosis, SI practitioners can contribute significantly to treatment. However, in the best interests of our clients, our work can seldom stand alone. The more severe the scoliosis – and the more complex the etiology – the more true this is. A client's history and the characteristics of the scoliosis give direction to the selection of team players. Some varieties of scoliosis are more amenable to our work than others. Since a wide range of tissue types may be involved, specialized training in visceral, cranial, neural, and vascular methods is often quite useful.

The client may already be working with other practitioners. Consult with them. If there's not a team in place, based on your initial understanding of the situation, recruit a team to assist this client. Over time, as you work, more information will emerge that will lead to adding other team members and/or pausing the work of some of them. The additional information may come from insights that you or any team member have based on assessment procedures and / or treatment results. Further, the client will usually volunteer additional information along the way.

Team members to consider:

The Schroth Method physical therapy: Physical therapist Christa Lehnert-Schroth developed a detailed method of analyzing scolioses to apply individualized, corrective muscle-strengthening and stretching treatment plans. This intensive program is often highly effective. The Schroth Method (http://www.schrothmethod.com) will be beneficial for nearly all types of scolioses. I advise structural integrators to develop cross-referral relationships with Schroth Method Therapists as our work is synergistic with theirs.

Neurologically oriented physical therapy: Some physical therapists are well trained in working with neurologic deficits. Some clients with cerebral palsy, strokes, or other known neurologic deficits are prime candidates for this type of work. All scoliosis clients should be evaluated for this possibility and, if neurologic deficits are found, continue to work with a specializing physical therapist. Shumway-Cook and Woollacott, mentioned earlier, have made lifetime studies of motor control and co-written an excellent and regularly-updated textbook (2017) on the subject. They also offer trainings in their approach.

Occupational therapy: Occupational therapists work with clients for whom tasks of daily living present challenges. They are very good at ergonomic problem solving and can assist people with scoliosis to find less stressful ways to use their bodies, which, in turn, fosters comfort and healing.

Cranial manipulation: Distortion in the cranium is a frequent component of scoliosis. I have seen a cadaver skull whose distortion was an obvious continuity of the scoliotic curve. Developmentally, the bodies of the occiput and sphenoid are vertebral bodies, essentially cervicals 0 and -1. (We number cervical vertebrae as C1-7 from the top down. Embryologically, there were two more vertebral bodies superior to C1 that become the basilar portions of the occiput and sphenoid bones.) Not attending to this part of the scoliotic curve will limit effectiveness in all parts of the spine. I recommend structurally-oriented cranial work such as discussed by Alain Géhin (1985). In my experience, the more 'energetic' forms of craniosacral therapy are less effective for this situation.

Chiropractic: Chiropractors move bones in the spine toward normal location. Often this requires repeated 'adjustment' because there are soft-tissue tensions holding the bones out of line. From long experience, I believe Rolfing SI and chiropractic can work very well together. The work we Rolfers do makes it easier for chiropractors to move bones, and the bones are more likely to stay put. In turn, chiropractors' work often facilitates our work. This applies to scoliosis as well as to other conditions, and is often particularly useful with scoliosis. Over the decades, chiropractic has diversified to a very large extent. While some practitioners in any chiropractic specialization are more skillful than others, my impression is that the following chiropractic specialties may be particularly useful for scoliosis: 1) *upper cervical specialists such as Nucca* (http://www.nucca.org/what-is-nucca/) – while all vertebrae are important, the upper cervical vertebrae are of particular importance since they house the brain stem; 2) *sacro-occipital technique* (SOT; https://soto-usa.com/what-is-sot/), a system that works particularly with the two ends of the spine and the relationships between those ends – think of it as another take on the Sixth- and Seventh-Hour relationships in Rolfing SI; 3) *Gonstead* (https://bit.ly/2UdVvTH), a system, quite compatible with SI, that makes careful structural measurements based on x-rays of all parts of the spine and then, based on this structural assessment, systematically prioritizes returning spinal segments to good alignment. Besides these, other varieties of chiropractic may be quite useful, depending again on the skill and insight of the individual chiropractor. Get to know the chiropractors in your area.

Prolotherapy (proliferation therapy) and platelet-rich plasma (PRP): Prolotherapy and PRP use the body's own healing capacities to heal injury by stimulating collagen fiber growth. Both involve specifically-targeted injections into injured areas. Prolotherapy uses a benign dextrose solution; PRP uses the client's own whole blood 'spun' or centrifuged to remove the red blood cells, thus producing a highly concentrated, platelet-rich plasma that also contains stem cells and growth factors. Both approaches can be highly effective for healing injuries that do not yet require surgery, such as tendinous tearing and ligamentous and capsular laxity. They are performed by medical doctors and naturopaths.

Nutritionist: As for any client, nutritional status is important. Over the decades we have learned more about what works nutritionally for humans. While general statements are made and are useful, physiology differs widely from person to person. Working with a savvy nutritionist to help figure out what works can give clients the tissue health to support the changes we introduce with Rolfing SI. Nutrition can be an important issue for any client; with scoliosis we need every extra point.

Sleep specialist: Many people have sleep that is either insufficient in quantity, quality, or both; those with chronic pain are especially prone to insufficient sleep. [There are many factors to good sleep. I recommend screening all clients for sleep hygiene. There are several perspectives on sleep hygiene with somewhat differing lists; one from Harvard Medical School (2007) is listed in the bibliography]. People with scoliosis, many of whom suffer from chronic pain, have a particularly difficult time finding a comfortable sleeping position. They are also significantly more likely than the general population to experience sleep apnea or, to use the more general term, 'sleep disordered breathing syndrome' (SDBS). There are three varieties of SDBS: obstructive apnea, central apnea, and upper airway resistance syndrome. *Obstructive sleep apnea* is where the airway in the throat closes during sleep, stopping breath for tens of seconds to minutes, possibly many times per hour. The result is dangerously low blood oxygen levels and interrupted sleep. *Central apnea* is where the brain stem fails to heed instructions for the body to breath. This can be the result of stroke, traumatic brain injury, or heart failure. *Upper airway resistance syndrome* resembles obstructive sleep apnea, but the airway does not completely close; rather, it is 80% or more occluded. This may not make blood oxygen levels as low as would obstructive sleep apnea, but it creates more persistently low blood oxygen levels. According to a NIH study by Heinzer et al. (2015), 25% of the general population in developed countries has some form of SDBS (http://erj.ersjournals.com/content/33/4/907); obstructive apnea accounts for 20% within the general population. According to a 2006 PubMed study (Nanaware et al.) 41% of people with scoliosis have obstructive apnea. With each of these syndromes, people stop breathing or don't breathe enough. Interrupted sleep leads to pathologically low oxygen levels. Untreated SDBS impedes healing and sabotages our work as SI practitioners. When a client backslides or is not improving during the SI work, consider SDBS as a possible factor. Unfortunately, SDBS is rarely helped by Rolfing SI or any other form of bodywork. The Sacred Heart Medical Center's Sleep Disorders Center makes a screening questionnaire for SDBS with scoring instructions available online (see bibliography).

Case Study

A fourteen-year-old girl was brought to me with a rapidly advancing scoliosis. At age eleven, a well-child exam had found no evidence of scoliosis. At age twelve, a mild scoliosis was noted. By age thirteen, her scoliosis had increased dramatically, she had constant neck, shoulder, and upper back pain, and she was referred to a regional children's hospital where she was fitted with a brace and told that if her curve did not improve promptly, surgery would be required. During the next six months, despite wearing the brace, her scoliosis had continued to increase. She came to me at that point.

In the first session I found dural-tube adhesions on twelve of her vertebrae, some each lumbar, thoracic, and cervical, all on the concave side of her primary thoracic curve. While common, the number of adhesions was remarkable, and, unusually, the arrangement was all on the left side of her neural canal. It looked suspiciously like the effect from an acceleration injury or whiplash-type event, with her head going to the right, thus injuring the left side of her dural tube. I asked her about this and she described an accident at age eleven, where she fell over a table, striking the table with her right side. This created a sidebending injury, over-lengthening along the left side of her body. It appeared that as the dural tube had healed, it had formed adhesions to the periosteum in the neural canal of half of her vertebrae, resulting in a shortening of the left side of her spine. As I released these dural-tube adhesions it became more possible to straighten her spine.

In her second session I noted extensive adhesions of her left lung; the entire lung was stuck to all its adjacent structures – parietal pleura of the chest wall, respiratory diaphragm, the wall of the mediastinum, as well as to the pleural fissure – upon which it should normally glide. Lung adhesions are common, but this sort of thorough adhesion along all surfaces is a less common pattern. It is consistent with having had pneumonia in one lung. When asked about this, the girl's parents revealed that, indeed, about a month after the sidebending injury, she had severe pneumonia in her left lung only. As I released these pleural adhesions it became yet easier to straighten her spine. At her next monthly check at the regional children's hospital, her spinal scoliosis was found to be five degrees less than at the previous exam, reversing the trend of her rapidly increasing scoliosis.

What appeared to have happened was that at age eleven she had a quick succession of two events, an injury and an infection, both affecting her left side. This was soon followed by the growth spurt associated with puberty. The fibrosed left lung and left-sided dural tube adhesions were not able to lengthen symmetrically with her right side during this growth spurt. The result was scoliosis. During the first two sessions mentioned here, many other tissues were also treated. Several more sessions followed. Full correction of the scoliosis was not achieved, but surgery was avoided and her pain was gone.

Jeffrey Burch was born in Eugene, Oregon in 1949 and grew up there except for part of his teen years in Munich, Germany. He was educated at the University of Oregon, Portland State University, and the University of Pavia, Italy, earning bachelor's degrees in biology and psychology and a master's degree in counseling. Jeffrey received his Rolfing certification in 1977 and his advanced Rolfing certification in 1990. He trained extensively in cranial manipulation with French etiopath Alain Gehin, and in craniosacral therapy with the Upledger Institute. Jeffrey trained to the instructor level in visceral manipulation under Jean-Pierre Barral and his associates. He has made substantial innovations in visceral manipulation, particularly for the thorax. Jeffrey has also developed groundbreaking new joint-mobilization techniques. He practices in Eugene, Oregon and offers continuing education classes in Eugene and other locations. For more details see www.jeffreyburch.com/biography.

BIBLIOGRAPHY

Géhin, A. 1985. *Atlas of Manipulative Techniques for the Cranium & Face*. Seattle, Washington: Eastland Press.

Harvard Medical School, Division of Sleep Medicine 2007. "Twelve Simple Tips to Iprove Your Sleep." https://bit.ly/1cYmchd. Retrieved 12/3/18.

Heinzer, R. et al. 2015. "Prevalence of Sleep-Disordered Breathing in the General Population: The HypnoLaus Study." *The Lancet. Respiratory Medicine* 3(4):310-318. Available at https://bit.ly/2BPHtkk.

Jennum, P. and R.L. Riha 2009. "Epidemiology of Sleep Apnoea/Hypopnoea Syndrome and Sleep-Disordered Breathing." *European Respiratory Journal* 2009 33:907-914.

Nanaware, S.K, D. Gothi, and J.M. Joshi 2006 Jul. "Sleep Apnea." *The Indian Journal of Pediatrics* 73(7):597-601.

Sacred Heart Medical Center, Sleep Disorders Center. "Sleep Quiz." Available at https://bit.ly/2KPnCV9. Retrieved 12/3/2018.

Shumway-Cook A. and M.H. Woolacott 2017. *Motor Contol: Translating Research into Clinical Practice*, 5th edition. Philadelphia: Lippincott Williams & Wilkins.

APPENDIX 1: GENERAL LISTENING

Each of our bodies has several 'lesions', several areas of localized tissue dysfunction. These several lesions are all linked by multiple pathways: connective-tissue fibers, nervous system, vascular, lymphatic, emotional, and hormonal. We won't always know all the pathways by which lesions are linked, but we can discover the body's priority for which one we should work on first to have the strongest therapeutic effect on the whole person. One of the most important keys to successful treatment is addressing 'lesions' in the right order. As practitioners, we have the constant question of what to do first, and what to do next. Fortunately, if we know how to listen, the body will tell us what structure to work on next, at every step of treatment. This kind of listening is the heart of success in manual therapy.

The body is constantly revising its system of compensations. New events happen to the body, the body ages, and the body constantly tries to find the best compromise that will leave it the most available adaptive capacity to meet new challenges. What we practitioners want to find is the part of the lesional chain that is most ready to destabilize; the area that is about to change anyway. If we treat this area of imminent destabilization, it will be relatively easy to do and the therapeutic effect will strongly ripple out to the rest of the body. We call this focus of strains that is about to change the 'primary restriction'. It is primary *only* in the sense that it is the one we should work on first. It did not necessarily occur first historically, and it is often not the strongest restriction in the body. 'Primary' only means that it is the one we should work on first.

We find the primary restriction using three related methods: 1) general listening, 2) local listening, and 3) inhibition. This appendix will introduce general listening.

To general listen, I stand behind my client and place my dominant hand gently but firmly on the top of the person's head, contacting the sagittal suture. Within three to five seconds, his/her body will lean in some direction, pointing me toward the primary restriction. We have an expression – 'the body hugs a lesion'. There is more to listening than this, but one metaphor is to consider the body as a structural column. When we put the weight of our hand on the client's head, the column will begin to collapse around (hug) a weak spot. This 'hug' is the primary restriction. As the client's body bends, watch what direction it goes – left, right, forward, backward? In addition to direction, see how far down the body the bend is. Is the bend at the neck? – at the diagram? – near the top of the pelvis? These two factors, direction and distance, point us to the zone of the primary restriction.

The next step is a method to check if we have the right zone. Keeping your dominant hand on the top of the head, with your nondominant hand gently touch the area you suspect of being the primary restriction. As you touch, have an intention to temporarily remove the effects of this lesion from the body's system of compensations. As you make this inhibitory touch one of two things will happen. One possibility is the body will right itself, moving out of the lean that the general listening showed you. This confirms your assessment. The other possibility is nothing will happen, the body will stay bent in the same direction. This tells you that you did not find the primary restriction. This is one use of inhibition.

There are eight more points I want to share about general-listening:

1. The weight and/or energetic effects of glasses, watches, jewelry, pagers, cell phones, etc. may skew the results of listening. Have these removed before listening.
2. From the client's perspective, it may feel odd to have you step behind him/her. One way to handle this is to say you are going to check some postural things. Step behind the client, check the heights of the iliac crests with your hands, then check shoulder levels with your hands. Finally, ask the client to close his/her eyes for a moment and put your hand on the top of his/her head.
3. It is important to be centered behind the person as you are listening, otherwise you may unintentionally pull the person in a particular direction. If you are short relative to the client, get on a chair so you don't have tension in your arm, which could also skew the pattern of movement.
4. If the client's eyes are open, s/he may use visual reference to stay level, and you will not feel in the listening. Have the client shut his/her eyes.
5. Listening happens within the first three to five seconds of contact. It may happen immediately when you contact. If you are there longer than five seconds, you may feel the body do many interesting things, but none of those things point you to what you should work on first.
6. The very first direction of lean is the important one. After the first one, the body may go a second, third, or fourth direction, but the information after the first direction is not useful. The first motion may be quite small and later motions much larger. Do not be distracted by these larger movements, but find the first one.
7. There is a variation of general listening you will need in a certain situation. If the person seems to bend near the hips, or if it is difficult to decide if the bend is in the legs or in the trunk, then have the person sit down, and listen again. If the seated listening is the same as standing, then the lesion is above the sit bones. If the seated listening is different than

the standing, then the primary lesion is below the sit-bones.

8. The quality of touch for listening is different than palpating deeper structures. In assessing motility you sink down to the level of the organ. In listening, you completely let the information come to you. Do not enter the body. If you sink into the body for listening the results will be inaccurate.

APPENDIX 2: ULTRA-SLOW MOBILITY TESTING

Concept

For any limitation in joint movement there are usually several limiting factors. Some of these limiting factors will be tissues that are shorter than others. Finding and releasing these in order from the shortest element to the least limiting one often works well. If the therapist moves the joint very slowly, the shortest limiting tissue will be encountered first. The protocol here is for joints. The same procedure is adaptable for a wide range of tissues.

Method

1. With the hands as relaxed as is practical, contact the tissue on both sides of the joint, close to the joint line. Feel into the joint and maintain awareness in the joint throughout the rest of the procedure, at the same time let your awareness be broad in surrounding tissues.
2. Mobility test the joint to end range. Note the results, both the excursion and the effort required to move through the range. Excursion will be greater in some directions than in others. Some directions may have less-than-normal range of motion, suggesting fibrosity. Other directions may have greater than normal mobility suggesting laxity. Note all these differences of normal range, subnormal range, and abnormally large range, as well as the effort required to move through the range.
3. Let the joint settle back to a neutral position.
4. Select a direction of reduced range in which you wish to increase the range of motion. (Do *not* choose a direction of laxity.) Displace the joint to end range in the direction opposite the direction you wish to increase, however if this is a direction of laxity exercise caution and restraint, displacing the joint to less than full range in the lax direction. Extremely slowly start to move the joint back toward the direction whose range you wish to increase. Initially a certain amount of effort will be required to move the joint, but after a short distance a greater amount of effort will be required to further move the joint. Precisely as this increase in effort is noted, feel the direction and location of the short element that is now resisting movement.
5. With palpation and knowledge of anatomy discern what this limiting factor is.
6. Return the joint to neutral.
7. Treat to reduce the fibrosity in the limiting area.
8. Retest the overall range of motion. Is it the same as before treatment or has it changed?
9. Again extremely slowly test the joint mobility as in step 4. Is the first limitation in the same area or in a different area?
    a) If the limitation is in the same area as before, treat it more.
    b) If the limitation is in a new area, return to step 7 for this new area.
10. Cycle steps 1-9, releasing progressively less short elements.
11. Mobility test to end range. Note how this is different from the original end-range mobility tests.

Important Elements

- Each joint will have more than one direction of movement. Explore each.
- Each joint will tolerate only so much work on a given day. Too much work will create inflammation. Inflammation will lead to more fibrosity in the long run. At the first tiny hint of swelling or edema stop for the day.
- Avoid pain, which is indicative of tissue damage. Ask the client to tell you if there is pain. Some clients will try to be stoic, but this is counterproductive. If the client experiences pain, *stop*. Try less force or a different technique. If a way is not found to work on an area comfortably, *stop*. Shift to working on another area.
- An analogy to this process is a weight suspended from the ceiling by not one but by several cords. The cords are not all of equal length so the weight is initially suspended by the shortest one or two. The shortest ones can be seen because of the gravitational load on them. When the shortest cord is lengthened we then see the next shortest one. One at a time the cords can be lengthened until the weight is distributed on them all. In this process any particular cord may be returned to more than once.
- The shortest limiting factor may not be the toughest. How short a tissue is does not correlate with how easy or challenging it is to change. Let yourself be surprised.