

Yoga Therapy for Scoliosis

Bringing Yogic Approach to Spinal Care

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Scoliosis and Evolution of Its Treatment Through the History

Although our understanding of scoliosis, what causes it, and how to treat it is a rather modern development, knowledge of the condition can be traced back to ancient civilizations, mainly from the medical treatises of Hippocrates and Galen. Hippocrates (5th-4th century B.C.), the father of spine surgery, was the first to deal with the anatomy and the pathology of human spine. Among many fields of medicine, he devoted much of his scientific interest to the in-depth study of orthopedics. In fact, some of the principles found in his treaties regarding fractures and joints are still valid today. In his books, there is a precise description of the segments and the normal curves of the spine, the structure of the vertebrae, the tendons attached to them, the blood supply to the spine, and even its anatomic relations to adjacent vessels. The Hippocratic list of spinal disorders includes tuberculous spondylitis, post-traumatic kyphosis, concussion, scoliosis, dislocations of the vertebrae, and fractures of the spinous processes. Scoliosis was discovered as early as the 5th century B.C. when Hippocrates attempted to counter what he saw as the 'luxation' of the spine (dislocation of vertebrae) with a kind of mechanical device—'luxation table' that was used as an effective method through the 16th century. He also developed a few other treatment procedures and devices to reduce displaced vertebrae, two of the most well-known apparatuses being 'Hippocratic ladder' and 'Hippocratic board'. Those pioneer methods are deemed to be the precursors to the advanced techniques used in spine surgery today. Nearly five centuries later, Galenos (130-201 AD), a Greek physician and surgeon, for the first time introduced the terminology for describing spinal deformities: σκολίωσις/skoliosis (from which the modern term derives) lordosis and kyphosis, provided etiologic implications and used the same principles as Hippocrates for their management, while his studies influenced medical practice on spinal deformities for more than 1500 years.

Mechanical means continued to be used through a good part of the history of scoliosis, and it was only around the 19th century and beginning of 20th century that came a systematic type of orthopedic or physiotherapeutic approach to scoliosis. This was supported by the founding of various institutions where rigorous treatments were given yet at a very high cost. Aside from lack of affordability for most people, such procedures were both work-intensive and staff-intensive because they involved manual adjustments. So as a way of overcoming these problems, they constructed different kinds of equipment that provided resistance or pull against the patient's body in place of physical resistance from the therapist. And generally, it was a combination of both the mechanical means and the correction by the therapist. Even then, most of the work were focused on a sort of passive reshaping. In some instances, they would employ various means to push the spine back into shape or apply pressure or passively force it to alter its shape. Patients were initially stretched using these devices then were immobilized in braces or plaster, sometimes for many years.

Up till 1905, delineates a period in which treating scoliosis was merely an ‘outside-in’ approach. Around 1905, greater attention was given to ‘muscular awareness’; the recognition that the muscles and their specific way of training play a crucial role in correcting scoliotic deformity. They began to realize that it is only through functional use that the muscles, ligaments and bones could be strengthened. They realized that the patient needs to take an active part in his/her own treatment in order to bring about change. And that had to counter play against a resistance exerted by the therapist to actually recruit muscles. So on that basis, exercises were developed which were curve specific. A 20th century German orthopedist named Bernard Klapp is considered as the forerunner of this kind of physiotherapy. Klapp’s method also known as Kriechmethode (crawling method), was a nonsurgical method established with the aim of correcting the spinal curvature by stretching and strengthening the back muscles to help retain the flexibility and strength as opposed to using casts and braces only. Oldevig (1793-1866), on the basis of anatomical principals, brought forth a new system comprised of belt exercises to trigger muscular activity. His emphasis was to isolate individual curvatures as to not exacerbate the compensatory curves during the exercises. Lange (1970) perceived scoliosis as a disruption of muscular balance. The method he used was to re-bend the spine on the concave side against the resistance of the device for the purpose of overcorrecting the primary curves while paying attention to compensatory curves.

In 1920s, a brilliant woman named Katharina Schroth from Dresden Germany, transformed the way scoliosis was seen and treated. She was suffering from a moderate scoliosis herself and underwent treatment with a steel brace at the age of 16 before she decided to develop a more functional approach of treatment for herself. Inspired by a balloon, she experimented the effects of breathing on the deformities of her own trunk which involved inflating the concavities selectively in front of a mirror. This had led her to develop not only certain pattern specific corrective movements (positions) that resemble versions of yoga poses but a asymmetric breathing technique to address the distortion of the rib cage that accompanies scoliosis. The technique or what she called as ‘rotational breathing’, was to breathe in such a way that doesn’t feel necessarily normal but actually makes the ribs and vertebrae to turn, altering the shape of the rib cage intentionally and with that, starts to change the bends and rotations of the spine. “She recognized that postural control can only be achieved by changing postural perception.”¹²

So, unlike all the techniques and viewpoints of the former years, for the first-time scoliosis was viewed not simply through mechanical terms. And that new way of understanding forged a new way for influencing scoliosis differently. From 1921, this new form of treatment with specific postural correction, improvement of breathing patterns and correction of postural perception was performed with rehabilitation times of 3 months in her own small institute in Meissen. She treated patients with very large curvatures, often exceeding 80°. After World War II, Katharina and her daughter, Christa Lehnert-Schroth PT, opened a new institute in West Germany which

grew to become a clinic with more than 150 in-patient at a time, treated for 6 weeks. Eventually, the Schroth method evolved under the leadership of her daughter and grandson, Dr. Hans- Rudolf Weiss. Katharina Schroth's concept behind her method for scoliosis correction was a development from years of self-examination and the corrective movements feasible. Called the "Body Block Concept", this explanation suggests that the body parts that comprise torso and those that are directly connected to it can be divided into different "body blocks" that ordinarily are stacked evenly. And according to this static mechanical concept of how posture changes with scoliosis, the blocks tend to first shift laterally and then also start to counter-rotated against each other, causing the distortion of scoliosis. Moreover, mirror monitoring is considered one of the key components as to allow coordinating the applied corrective movements and the postural perception with the visual input. Her method established upon principles of breath, awareness of weight bearing to foster greater body awareness to better overcome faulty habits of holding the body in ways that aggravate the curvature, thus facilitating a desired correction. "Why is it so often the case that gymnastic efforts to straighten out the spine so often result in failure? Because one approaches the child in a far too mechanical way. Getting the external person to stand up straight and erect their spine will only be possible if you first allow the inner person to stand up straight, to give them hope, to allow them to breathe out.", said Katharina Schroth.

Corrective treatment based on the Schroth method principles is presently applied worldwide. Collaboration with Dr. Jacques Chêneau gave birth to a new Schroth method compatible scoliosis bracing approach. The most recent advancement of Chêneau bracing is the Gensingen Brace® (GBW). These braces have an asymmetric design and rely Schroth principles of correction in a smaller, lighter, more wearer-friendly brace. Today, there are three proven treatments—observation, bracing, and surgery—which are recommended based on the severity of the scoliosis and the physical maturity of the child. Physiotherapy Scoliosis Specific Exercises (PSSE) may be administered in some cases yet mostly for idiopathic scoliosis during growth. PSSE is part of a scoliosis care model that includes scoliosis specific education, scoliosis specific physical therapy exercises, observation, psychological support and intervention, bracing and surgery. Although more than 2,000 years have passed since Hippocrates' era, nonetheless the main approach of conservative scoliosis has been based on mechanical viewpoints in the early 20th century and in most of approaches still existing today. As mentioned before, they are mostly 'outside-in' methods in which some important elements beyond the mechanical aspect are missing.

Overview of Scoliosis

Biotensegrity suggests that the human body and in particular the human spine is a complex 3-dimensional tensegrity (tensional integrity or floating compression) structure—one that is floating upright inside a net of continuous tension created by our fascial network. Based on this concept, the continuity and integrity of it, is because of its tensional elements—the skin, muscles and the fascial structures (connective tissues). Our bones including the vertebral bodies don't pass load directly to each other. As such, forces flow through the tensional elements primarily instead of flowing continuously through the compressional elements—bones. This means that the hard pieces are kept in contact with each other using force that presses them together. This way, the entire structure remains intact. In scoliosis, this interplay of forces is impaired resulting in the sustainability of improper amount of spacing between joints and tension in the structure as a whole. Scoliosis (from the root *skol*, meaning bent or crooked) is a three-dimensional type of spinal deformity, characterized by a lateral curvature of the spine and the rotation of the affected vertebrae toward the side of the convexity that occurs most often during the growth spurt just before puberty. The rotational component that combines to asymmetries between two sides of the body—the bulging side (convex) and the compressed side (concave)—often exaggerates the normal curves of the spinal column, increasing both the lordosis of the lumbar and kyphosis of the thoracic spine. Scoliosis can be a progressive condition and long term effects can prove daunting. The greater the curve angle, the greater the interference with normal function over time. The scoliotic spine may appear as a “C” or, if it has a compensatory curve, an “S”. Although curvature can occur in a variety of areas along the spinal column, the abnormal curve can manifest in the thoracic spine, the lumbar spine, or both regions at the same time. There are four most common patterns of deviation—right thoracic (right convexity in mid-back), left lumbar (left convexity in the lumbar), right thoraco-lumbar (commonly known as a “C” with major curve being to the right in the lower thoracic and lumbar), right thoracic-left lumbar (commonly known as an “S”). The scoliotic spine can therefore be explained as a structure whose constituent elements are no longer able to maintain their physiological alignment. The asymmetrical distribution of the load and the progressive deformation of the vertebrae gradually decrease the spinal column's capacity to retain stability. About 9/10 of scoliosis cases occur in females that can have genetic explanation. Females are eight times more likely to progress to a scoliotic curve of a magnitude that requires treatment. “There is obviously something muscular about most cases of scoliosis; women have more delicate physiques that increase their susceptibility to muscular problems and improving the spine's range of motion is known to deepen the curves.”⁵

Symptoms vary depending on the degree of scoliosis. Some of the common symptoms include: one shoulder or shoulder blade higher and more prominent than the other, rib cage appears

higher on one side than the other (rib hump), the body tilts to one side, uneven hips, one leg may appear shorter than the other, breathing problems, and back pain.

Many cases of scoliosis are painless. As the condition progresses, back pain can develop. The deformity may cause pressure on nerves and possibly even the entire spinal cord. This can lead to weakness, numbness, and pain in the lower extremities. In severe cases, pressure on the spinal cord itself may result in loss of coordination in the muscles of the legs making it difficult to walk normally. Finally, if the chest is deformed, the lungs and heart get affected leading to breathing problems, fatigue, and even heart failure.

80% of all types of scoliosis are Idiopathic Scoliosis (IS)—of an unknown cause or mechanism, and of these, 80% occur in adolescents (around the onset of puberty). The cause of AIS in humans remains obscure and probably multifactorial though a genetic component is suspected. At present, there is no proven method or test available to identify children or adolescent at risk of developing AIS or identify which of the affected individuals are at risk of progression. Reported associations are linked in pathogenesis rather than etiologic factors. Melatonin may play a role in the pathogenesis of scoliosis (neuroendocrine hypothesis), but at present, the data available cannot clearly support this hypothesis. The correlation between the hormone melatonin and scoliosis began with animal studies. Experiments were done in which the pineal gland was removed from animals. This resulted in animals developing spinal deformities. Since the pineal gland is responsible for secreting melatonin, it was hypothesized that absence of melatonin caused the spinal deformity. To further the experiment, melatonin was then given to animals and that prevented the development of the deformity.⁶ The results however aren't as clear-cut with human studies. A few studies found lower levels of melatonin in scoliosis patients. Interestingly, low melatonin levels have been linked to patients whose curves progressed rapidly. And patients with normal melatonin levels had curves that were stable or progressed slowly.⁷ Therefore, melatonin level can be a useful indicator for progression of curvature in idiopathic scoliosis. It is suggested that normal melatonin production or metabolism may have crucial role in regulating normal spine growth. Other common types include congenital/osteogenic scoliosis—refers to a spinal deformity caused by vertebrae that are not properly formed—secondary to vertebral anomalies, neuropathic scoliosis (in patients with syringomyelia, tethered cord, Chiari malformations, diastematomyelia, and meningocele/myelomeningocele), and neuromuscular scoliosis (in patients with cerebral palsy, spinocerebellar degeneration e.g. Friedreich ataxia, muscular dystrophy, and poliomyelitis). The distinction between different types of scoliosis is important with respect to treatment and prognosis.

A study demonstrated that patients with idiopathic scoliosis differ significantly from those with neuromuscular/neuropathic scoliosis in terms of curve length, curve form, and location of the lower-end vertebra. Atypical (left thoracic) scoliosis occurred more often in individuals with

neuromuscular/neuropathic scoliosis. S curves occurred exclusively in those with idiopathic scoliosis. However, S curves can also occur in congenital/osteogenic scoliosis when the vertebral anomalies involve the thoracic and lumbar vertebrae separately. Patients with congenital/osteogenic scoliosis often have a short curve length (3–4 vertebrae). A curve length of >8 vertebrae, a non-S curve, and a lower-end vertebra located at L4 or L5 seemed more likely to be neuromuscular/neuropathic scoliosis in origin.⁸

A small controlled trial, published in the *Journal of Orthopedic Surgery*, found that people with idiopathic scoliosis are more likely to lean on the right leg during standing and have right hip adduction deficit. Of 102 patients (mean age, 14 years) with idiopathic scoliosis, 64 (63%) had an adduction range deficit of the right hip, 4 (4%) of the left hip, and 34 (33%) had no difference in adduction range between two sides. They were then subdivided into 2 groups by the extent of hip adduction deficit. In group A (n=11), 3 had a single curve (mean, 27°) and 8 had double curves (mean, 30° and 30°), whereas in group B (n=51), 23 were with a single curve (mean, 29°), 25 with double curves (mean, 28° and 26°), and 3 with triple curves (mean, 22°, 21° and 25°). In group A, the right hip adduction deficit was >10°, whereas in group B it was ≤10°. There were no significant differences between the 2 groups in Cobb's angles, right leg preference during standing (46% vs 45%), and right hip flexors tightness (55% vs 38%), but there was significant difference for leg dominance. Results showed that there was a higher proportion of left leg dominance among those with >10° of right hip adduction deficit than patients with ≤10° (18% vs 4%).⁹

Scoliosis diagnosis is based on a patient's medical history, physical examination, and other diagnostic tests if needed. Highlights of the patient's history include information relative to other family members with spinal deformity, assessment of physiologic maturity (eg. menarche), and presence or absence of pain. The physical examination involves first observing the back while the person stands to see if the shoulders or waist seem uneven. Next is what's called the Adam's forward bend test to check how even the back appears. Anything that looks abnormal in the back or ribcage, like a hump, might be a sign of scoliosis. As part of the forward bend test, the clinician might use a scoliometer (or incliometer) to estimate the angle of trunk rotation (ATR) in degrees. If the test is positive, an X-ray confirmation of the abnormal lateral curvature and spinal rotation is then will be performed and the Cobb angle measured. Posteroanterior and lateral radiographs are typically utilized to determine curve progression and osteogenic abnormalities. MRI is the diagnostic tool of choice to rule out intraspinal pathology and neural axis abnormalities, yet is less accessible and involves general anesthesia especially in very young children. Computed tomography scan (CT or CAT scan), on the other hand, has more affordability, but carries the risk of exposure to ionizing radiation. It can be used to define vertebral anomalies associated with scoliosis and to measure the degree of vertebral rotation.

The *Cobb angle*, named after American orthopedic surgeon John Robert Cobb (1903-1967), is the primary standard of measurement used to quantify the magnitude of spinal deformities, especially in the case of scoliosis, which helps the doctor to determine what type of treatment is necessary. Nonetheless, the Cobb's approach only assesses the degree of side-bend two-dimensionally without fully considering the aspect of rotation. Therefore, it may not accurately show the severity of a deviation. A Cobb angle of 10 degrees is regarded as a minimum angulation to define scoliosis. Those with 10-15° normally do not require any treatment except for regular check-ups until the patient has gone through puberty and finished growing as the curve of the spine usually do not worsen after puberty. When the curve enters the range of 20 to 40°, the orthopedic generally prescribe a back brace, with some worn for 18 to 20 hours, others only at night time. Surgical treatment is indicated, in general, for a curve exceeding 40 to 50 degrees on the basis that:

- i. Curves between 40-50° at skeletal maturity progress at an average of 10 to 15 degrees during a normal lifetime.
- ii. Curves larger than 50° progress even after skeletal maturity at about 1 to 2 degrees per year.
- iii. Curves larger than 60° cause loss of pulmonary function, and much larger curves cause respiratory failure.
- iv. Greater the curve progression, the more difficult it is to treat with surgery.

Posterior fusion with instrumentation has been the standard method of surgical treatment for scoliosis. In modern instrumentation systems, more anchors are used to connect the rod and the spine as to achieve better correction and less frequent implant failures. Segmental pedicle screw constructs or hybrid constructs using pedicle screws, hooks, and wires are the trend of today. Anterior instrumentation surgery was once the choice of treatment for thoracolumbar and lumbar scoliosis because better correction could be obtained with shorter fusion levels. But in the recent times, superiority of anterior surgery for the thoracolumbar and lumbar scoliosis has been questioned.

Yoga Versus Yoga Therapy Approach to Health Care

Although yoga has clearly been shown to have numerous health benefits, and various protocols have proven helpful for people with a variety of health disorders, not all yoga is suitable for all conditions including scoliosis. Hence it is imperative to understand that yoga therapy is completely different from simply taking a yoga class. Generally speaking, one commonality

among yoga classes is their “one size fits all” approach, that is, the same set of practices is given to each practitioner with the objectives of lowering stress levels, improving flexibility, stamina, and mental calmness or concentration. Holistically viewed, since no two persons are alike, thus in the clinical practice of yoga therapy, the proposed plans greatly vary, even for individuals with identical diagnoses. People with scoliosis, for instance, may vary in terms of curve form, severity, their stage of treatment, the amount of time they can devote to their yoga practice, and in addition varying in co-morbid conditions. They also have differences in physical make-up, genetics, personal history, lifestyle, the degree of curve, strengths and weaknesses, fitness level, overall health and psychological well-being. Each of these factors can influence which practices are recommended and often more importantly, which practices are not. Yoga therapy, unlike a general yoga session, is not a one-size-fits-all proposition but rather a patient-centered individually tailored approach. “The personalized process is analogous to yoga therapy which empowers individuals through the teachings and practices of yoga to maintain a consistent practice that increases self-awareness, engages their energy in the direction of desired goals, and changes their relationship with their condition”.¹ Fundamentally, yoga therapy follows an intricate and systematic model of care with first step being the assessment. Assessments are crucial in the design of a safe, individualized program. In one-on-one setting, the therapist performs a detailed health assessment (a health risk appraisal) on his/her client. Although this health assessment shares some of the methods of Western approaches to mind-body medicine but also includes methods that derive from yoga’s particular understanding of physical structure, the breath, and other aspects of the mind and body as well as considering the client’s social environment and general lifestyle information. Gathering personal information about an individual is very key in gaining an understanding of the individual as a person on a continuum of life experiences—physical challenges, thoughts and emotions, relationships—allowing for a tailored therapeutic strategy to suit the client that may be altered regularly as the individual’s situation changes. In yoga therapy, a combination of postures (*asana*), breathing techniques (*pranayama*), chanting, meditation (*dhyana*), visualization and so on are modified, adapted and/or simplified to suit the capacity and needs of individual patients. This largely alludes to the fact that the approach of yoga therapy is patient-controlled; meaning the patients are not regarded as passive recipients of therapy but rather they are actively involved in their own care. One of the models commonly employed in yoga therapy involves the concept of the *koshas* (the five layers or sheaths)—the five layers of our existence, each made of increasingly finer grades of energy. Understanding the individual’s functional status on each of these levels as well as their core strengths helps the therapist in charting well-balanced therapeutic interventions addressing multidimensional system of the person. Implementing the essential tools that yoga therapy has to offer for scoliosis can effectively address the entire person—all of the *koshas*—through provision of a therapeutic intervention factors. Regardless of the focus of yoga practices with therapeutic purposes, the central ethics are derived from yoga philosophy. *Ahimsa*, the yogic

principle of nonharming forms the foundation of yoga therapy and therapists strive, above all, to avoid inducing harm.

Summary of My Findings: Yoga Therapy Mechanisms of Effectiveness for Scoliosis Based on A Case Study

“Consideration of a patient’s entire situation—body, mind, spirit, and environment—is a manifestation of holism, more commonly referred to in the clinical context as holistic medicine, or more recently as integrative or participative medicine. Conventional medicine, in contrast, tends to focus on discrete and often isolated targets when assessing a patient and his/her condition.”¹ This statement clearly elucidate the holistic nature of yoga therapy. Seeing scoliosis as a multifactorial condition with many factors and functions interconnected, allows yoga therapy to address multiple interrelated domains—physical, mental, emotional, social, spiritual—with a multicomponent approach.

The subject according to whom I am presenting my findings is a 30-year old female. K. Orofino’s case of scoliosis was not a congenital type and rather of a very recent diagnostic finding. It was a mild C-type scoliosis of the upper thoracic spine with an apex at T3 and T4 with epicenter on the left side (convex). She has been having MRIs regularly since the development of a benign tumor in her left femur (which has been removed) and no sign of scoliosis has been evident up until January 2018. At that time, there was no medical investigations being done with respect to any possible correlation between leg length variation (right leg longer) and onset of her scoliosis. Our course of therapy began in March and continued for a duration of 3 months (9-protocol plan + pre and pst assessments). During initial sessions, she showed an overall poor body awareness, poor proprioception, and inability to monitor her breathing in terms of depth and pattern (e.g. inability to differentiate fullness of breath between the right and left). Simply put, for Karina noticing such things as bodily states or postural positioning were some foreign concepts. “I don’t have a faintest idea about what’s happening in my body! It’s hard to notice where my breath is full and where is restricted! I can’t tell which of my shoulder blades feels heaviest on the ground”, said Karina in her initial assessment. Visible misalignments completely felt natural to her. I also noted a noticeable degree of asymmetry in the muscle tone between the convexity and concavity, postural shifts (anterior and lateral shift of the hips), and distorted breathing mechanics and capacity. The following list summarizes the specific mechanisms by which our yoga therapy sessions could transform her scoliotic care and her overall quality of life.

- Enhancing Body Awareness

In scoliosis, the sensory map of the body becomes disoriented. That is to say the brain can’t have an accurate map of where the segments of the body are located in space. Because of this distortion in body perception, the brain is unable to conduct posture and movements properly. In

consequence, mal-positioning of the body will result, eventually causing mal-adaptations to positional imbalances. These faulty adaptations cause disorganization of the posture driving scoliosis toward progression and thereby contributing to what is known as the vicious cycle of scoliosis. Thus improving sensory motor awareness should be addressed in conservative treatment of scoliosis. And clearly yoga therapy can help with this particular aspect by working on enhancing body awareness. Body awareness is part of the larger concept of awareness that is central to all components of yoga therapy. With cultivating awareness comes the possibility of making healthier changes. It was through cultivating self-awareness (self-observation), for example, that Karina could refine her postural alignment. In the course of our asana work with her, self-observation fostered higher sensitivity to the asymmetries of her body and taught her how to intelligently differentiate and integrate its concave and convex sides. A unique sense of objectivity developed, allowing her to explore her movement patterns and find areas of tension, restriction, strength and weakness, and imbalance in her mind and body. In a way, she was learning how to relate from a careful, accepting, nonreactive perspective to not only her bodily sensations and sensory experiences but her mind states—difficult thoughts and emotions—as well. This, in turn, opened the way to a deep sense of physical self-understanding, reduced maladaptive movements, correction of postural strain, and modification of attitudes and behaviors that could contribute to her condition. By session 2, in such a short period, some major shifts were taking place in terms of quality of mind-body awareness, posture and even degree of shift/rotation towards left. Using such methods as MELT (myofascial release method), for instance, helped her to improve her body awareness and proprioceptive abilities and showed to be particularly effective in addressing stuck stress in her shoulder girdle and pelvis. Following MELT while in supine position, she would share, “my upper back feels more even and balanced, more weight on the buttocks than tail and backs of thighs felt more evenly weighted.” Through sustained practice, mind-body awareness will thrive, new neural networks are forged and reinforced supporting the new habit patterns to flourish and become progressively stronger. Thanks to neuroplasticity (the adaptability of our nervous system), as the brain adapts to new and improved information, it begins directing muscles around the spine to adapt to a ‘new normal’ resulting in postural adjustments that support the spine. “There is increasing consensus that body awareness is of substantial significance for health and self-regulation. For example, enhanced body awareness can reflect an increased ability to observe bodily signals of emotional states without getting caught up in them.”¹ Furthermore, given that people with scoliosis may have lost connection with their mind and body, yoga can aid them to feel more connected and safe in their bodies, an integral part of the healing process.

Beyond the awareness of the body, continuous observation of the breath progressively conditioned Karina how to pacify emotional reactivity, heighten awareness of the energetic dimensions, and awaken the witnessing mind. By directing loving attention to her breath while

aligning herself in postures, she learned how to transform the pain or feelings of imbalance into self-acceptance and freedom.

- Improving Posture and Body Mechanics

Impairment or injury to the human movement system (HMS) rarely involves one structure. Because HMS is an integrated system, impairment in one system leads to compensation and adaptations in other systems. If one segment in the HMS is out of alignment, then other movement segments have to compensate in attempts to balance the weight distribution of the dysfunctional segment. This places abnormal distorting forces on the structures that are above and below the dysfunctional segment. Therefore, we can consider scoliosis as a kind of multifaceted impairment syndrome in which the structural integrity of a person is compromised not only the back. The spine is not an isolated body part and scoliosis is not simply a laterally shifted spine but rather the entire body gets affected. Hence, for a therapeutic approach to scoliosis to succeed, the spine must be seen as an integral component of a ‘*whole*’ human being. To be clear, for such an integrated system that functions in an interdependent, interrelated scheme we need to undertake an integrative system of care to achieve maximum, lasting results.

Knowing that the scoliotic spine is asymmetrical, the way the therapist educates the practitioner to approach the pose will be different from one side to the other. Specific curve-pattern classification is essential prior to initiating any regimen and a discussion with the client’s treating physician is highly recommended. Having the process be monitored by the physician helps the therapist determine which poses are the most beneficial or harmful and more importantly for being aware of other conditions that may be limiting the patient’s ability to recover asymmetry. Radiculopathy (pinched nerve roots), hip or sacroiliac joint abnormalities, neuromuscular or cerebrovascular problems, or even anemia are some of these conditions. Therefore, to use yoga effectively, the poses need to be curve-pattern specific with overall goals of facilitating 3-dimension correction of the altered posture and training activities of daily living (ADL) in order to minimize progression of spinal deformity.

Through a selective postures/movement sequences that emphasized symmetry and midline, Karina could develop centralized sensitivity and the ability to balance and adjust both the convex and concave sides (obtaining a state of well-balanced tension). And by setting up a contrary process that involved elongating the muscles that had become overactive (shortened) and strengthening the muscles that had weakened (lengthened) from the asymmetrical imbalance of scoliosis, desired realignment of the body was attained. Once asymmetry was reduced, her body relearned to rely more on its bony structure to hold itself upright and the muscles seemed to function more efficiently to maintain that optimal alignment. Another important function that I as a yoga therapist aimed to improve, was the stabilization of the spine, namely, the efficacy of the

stabilizing muscles of the spine to counteract the evolution of the curve. Because the evolution of a progressive scoliosis always runs towards a worsening condition, working to strengthen back (postural) muscles was key, like the multifidus, which are essential for stability and posture and provide a solid foundation for movement of the arms and legs. “Previous efforts had often concentrated on improving the spine’s range of motion. Because gravity’s force amplifies the muscular asymmetry already present in scoliosis, as the range of motion increase, gravity just takes up the slack and pulls the spine even further to the side and off the midline.”³ Naturally, as the strength of the quadrates lumborum, iliopsoas, and paraspinal of the bulging area improves, and as body awareness heightens, the muscles themselves can increase the range of motion asymmetrically, facilitating the spine to straighten (equalization of muscles’ pull) while supporting it to remain in that state. And only when she learned how to correct the asymmetry, our focus shifted on toning the core musculature in order to preserve the correction. The core muscles that keep the torso better aligned and may as well relieve back pain are the oblique muscles, the rectus and transverse abdominis, and, in the back, the multifidus and erector spinae. One prime example of an asana incorporated throughout all of our protocols that has proven effective in treating scoliosis was vasishtasana (side plank pose). Karina was systematically progressed from lying sideways (convex side down) with forearm and hips on the floor and raising only the midsection and ribs of the concave side, to the classic pose (the traditional straight arm variation) itself. The side plank works the obliques as part of the core, addressing in particular shortness and weakness in the waist that results from the lateral shift of the hips and compensating tilt of the rib cage. Having the top hand behind the head facilitated to both traction the neck and worked amid back muscles against the thoracic hump. When we started, Karina had noticeable difficulty in contracting bottom ribs (drawing-in maneuver) while lifting and spreading top ribs but in time, she made consistent and significant progression to a point of staying lifted (with optimal alignment) with both feet resting on a chair which is the hardest variation. As mentioned before, having scoliosis alters one’s proprioceptive abilities (perception of position of body parts in space) since the nervous system is distorted and because the joints are at an angle (misaligned). Therefore, the nerve pathways are different and the person has a different proprioceptive feedback. So people with scoliosis will have a distortion of where they are in space and use of specific props such as blocks, straps, and bolsters can serve as external references of organization. The purposeful use of wall in standing postures and ground in lying positions was significantly instrumental in informing Karina of her habitual posture as well as giving the opportunity to learn; to retrace patterns and establish new ways to organize herself in space. In this way, our therapeutic sessions improved and fine-tuned her movements and positioning by focusing the awareness on spatial, interoceptive, proprioceptive, kinesthetic sensations; all of which are the defining characteristics of meditative movement.

Dr. Loren Fishman, a leading pioneer in the therapeutic applications of yoga for chronic physical and structural issues conducted a study in collaboration with Karen Sherman and Eric Groessl,

leading researchers in the yoga therapy applications for back pain. Of 25 participants, nineteen completed the requirements of the study, practicing a single yoga posture (side plank: *vasisthasana*) on convex side only more than three times a week. Their progress was then evaluated after a mean follow-up period of 6.8 months (ranging from 3 to 22 months later), and the pre and post Cobb measurements were compared. The overall improvement in spinal curvature was an average of 40 percent, however adolescents showed greater improvement (49.6%) than adults (38.4%).

Another example for efficacy of yoga, is a case of a 40 years old woman who was diagnosed with idiopathic scoliosis and recommended as a candidate for spinal fusion during her early adolescent years. She instead opted to try conservative therapy sessions for about a year. Then, she decided to practice somatic movement reeducation techniques and yoga, mainly Body-Mind Centering™, The Feldenkrais Method™, swimming, and Iyengar Yoga. The subject has been studying and teaching Iyengar Yoga, supported by movement reeducation practices, on a daily basis. The yoga regimen has helped her to stabilize weak muscles; enhance the range of respiration; increase postural tone in standing, sitting, and lying; and strengthen and lengthen the spine through specific postures used as traction. Movement reeducation based on the integration of concepts of bio-mechanics and motor development has improved the subject's proprioception, sensibility, and awareness of functional movement. She is now 46-years-old and pain-free, living a functional and active life.

▪ Enhancing Respiratory Capacity and Function

It has been well documented that people with scoliosis experience movement limitations in their rib cage and lungs. Because of the twists and curves of the spine, all of the stabilization muscles of the trunk get affected. These muscles serve both as an elastic webbing of postural support and as key players in the process of breathing. So the breath can be one of the first things affected by scoliotic posture. For the lungs to function efficiently, the rib cage must have the strength and flexibility to expand and contract freely. As the condition progresses, the rib cage becomes progressively asymmetrical and inflexible, with one side splayed open and the other side compressed densely together, interfering with deep inhalation and exhalation. In simple terms, the asymmetrical shape of the ribs caused by vertebral rotation makes the normal breathing pattern to be asymmetrical which can then adversely worsen the rotation and distortion. The inflexibility of the rib cage inhibits the role of other key breathing muscles, making the diaphragm to act alone. And even the diaphragm has to function within distortion because its points of contacts are dislocated due to rotation. This consequently reduces vital lung capacity, resulting in an unhealthy pattern of shallow breathing. It has been noted that faulty breathing patterns (shallow chest breathing versus proper diaphragmatic breathing) can alter carbon

dioxide and oxygen content of blood, which perpetuates dysfunctional breathing. Hence improving breathing mechanics that has been compromised due to asymmetrical shifts, compression and bulging of the ribs was explicitly a vital part of the Karina's plan.

Generally, there is lack of awareness in the areas of the body that collapse—areas deprived of circulation, nourishment; energy (prana)—from the lateral bends and rotation of scoliosis which brings with it great discomfort and/or even pain. Because each side of the chest receives unequal amounts of air; larger volume enters the lung on the convex part (oxygen distribution impairment), more asymmetry results; the convex side continues to expand further while the concavity increases even more. So to reverse this process, the first step will be honing the awareness of where the breath flows. A good place to start is noticing things such as: where the breath is full and where it's restricted? Does it differ from the right to the left and front to back? How about from top of the lungs to the bottom? Once we understand where the breath is going and where it's restricted, we can direct it into the underused areas. And as more breaths consciously streams to the collapse areas, an enlivening effect springs, the discomfort is relieved and the cycle of collapse diminished at will. Biologically speaking, something else also takes place as increased vasodilation. That is; the tissues can receive adequate amounts of oxygen and nutrients as well as removal of waste byproducts (via blood) to facilitate tissue recovery and repair. This unique way of working with the breath that yoga offers is quite compatible with the 'Rotational Angular Breathing' (RAB) of the Schroth's method that has been shown to help de-rotate the spine, strengthen the weakened muscles and lengthen the shortened muscles. RAB emphasizes breathing intentionally into the constricted side of the ribcage so that the corresponding side of the diaphragm acts to lift the ribs out and up on that side in a right angle fashion (right angled breathing). Similarly, the breath also helps to open the floating ribs out and up of the convexity (in severe cases wherein the floating ribs can point nearly vertical on the side of the bulge/hump, hindering the movement of the diaphragm) while the overall rib cage de-rotates on the concave side, lessening the concavity. A slow-breathing pranayama of the *ujjayi* breath (victorious breath) in conjunction with diaphragmatic breathing is particularly a key tool for this work. Of note here is that if right angled diaphragmatic breathing is to be effective in mobilizing the ribs to ameliorate the distortion of the ribs, the distention of the belly needs to be limited through the resistance of the abdominal tone. Ujjayi is a deep, slow, and rhythmic diaphragmatic breath that is performed through the nostrils with concurrent narrowing of the glottis, which creates a soft soothing sound. The sound and texture of the ujjayi tells about fullness of the breathing. If hearing coarseness, irregularity or constriction in the ujjayi, we know that tightness or contraction may be present. The breaths notifies us to the places where we are closing off or holding back as well as a deep state of agitation or conflict within the body. For Karina, adaptation of ujjayi with specific focus on channeling larger volume of air to the concavity from base of the lungs (RAB method) was another key to her overall improvement. It

methodically conditioned her to deepen the breath, directing it to underused areas as to even out the expansion of the rib cage with awareness and sensitivity. This discovery had a profound effect upon her practice as well as state of being. She began to realize that she needed to focus her breathing into the concave side opposite of her curve in order to strengthen the intercostals and create more space between the ribs. Having gained more control, she then was able to focus her inhalation on expanding the ribs and intercostals equally on both sides and releasing them slowly and evenly on the exhalation. Overtime, this conscious control of breath taught her how to use her breath as an influential way for cultivating changes from inside out which is key for scoliosis. To further the enhancements, we then incorporated another powerful pranayama into the mix, the so-called *dirgha swasam*. Known as the “complete” or “three-part” breath—filling the three chambers of the lungs—this technique encourages full, diaphragmatic breathing, important since scoliosis can impinge upon lung capacity. Towards the end of our work, Karina had advanced so far to a point that she could execute *dirgha* ever so skillfully, filling the lungs from bottom to top on inhalations and emptying from top to bottom on exhalations. The practice gave rebirth to her right lungs and ribs, which had become comparatively inactive due to the curve and misalignment.

It should come as no surprise that manipulating (regulating) the breath in such an informed way, not only can improve the curve, but also can have widespread effects on other parameters of health including psychophysiology and respiratory functions. Such effects include:

- Stimulation of somatosensory vagal afferents to the brain and in turn promoting autonomic regulation (ANS)
- Increase parasympathetic activity (PNS)
- Promote the release of prolactin and oxytocin, which can foster feelings of calmness and social bonding
- Improve psycho-neuro-endocrine-immune modulation, maintaining homeostasis through afferent tracts (to the hypothalamus, central ANS, limbic system, thalamus, and cortex) and efferent tracts (cholinergic anti-inflammatory pathways) to the organs and tissues of the body.¹
- Reduce perceived stress and reverse negative effects of stress on immune system
 - Increases levels of immunoglobulin A and natural killer cells
 - Decreases inflammatory markers such as high sensitivity C-reactive proteins as well as inflammatory cytokines
- Alleviation of negative psychological states (e.g. depression, anxiety, PTSD)

- Optimized Nervous System Function

It is an oversimplification to say that yoga simply calms the nervous system. Many practices like vigorous pranayamas and backbends actively invigorate the SNS, so the benefits exceeds beyond just relaxation. For individuals suffering from scoliosis and other trauma-related conditions, the dysregulation of the ANS may underly many, if not all, of the symptoms, thus regulating this system is a prerequisite for improvement. Within the context of yoga, what is most desirable is a finely tuned autonomic nervous system (ANS) that respond effectively to life stressors of any kind, shifting the relative activation of the PNS and SNS accordingly. In our protocols, through integration of activating (i.e. standing postures) and calming techniques (i.e. restorative postures, alternate nostril breathing, witnessing breath, guided relaxation practices) both branches of ANS were intended to be strengthened and brought into better state of balance. Researchers examine the ANS function by evaluating such measurable factors as how well the body perceives and adjusts to changes in body position (baroreceptor sensitivity) and whether the heart maintains a healthy subtle variation in its rhythm, termed as heart rate variability (HRV). And evidently yoga seems to improve both of these measures.²

- Improved Self-Image and Self-Esteem

Aside from gait, posture, and other areas of physical functioning, scoliosis can negatively affect body image, measurably undermining self-esteem. With time, that body image turns into a type of personal story—internal dialogue—that revolves around one’s body, a theme with which the person can certainly identify. Consequently, one’s sense of self-worth become tightly bound to the body, making the person to believe that the curvature is symbolic of inadequacy, self-loath, and failure. A distorted body image may influence everything from how you treat yourself to how you relate to others (feeling inferior). It can even prevent you from taking good care of your health, as you feel unworthy.

This is where the mind-body-spirit approach of yoga therapy can support the client to move beyond her or his stories and tap into an internal space of expansiveness and wisdom. Each of the practices of embodied awareness naturally guided Karina toward the creation of internal space supported by the trusting relationship—the sense of social safety—with her yoga therapist. Within that newly found space of greater self-acceptance, she discovered a sense of freedom to move away from the mentality of “why is this happening to me?” and grow to more profound questions, such as, “what does this experience have to teach me?” This form of inquiry invited her psychological processes to shift from habitual negative patterns of thinking and behaving (self belief system) to build and sustain the self-awareness required for change. After all, a different mindset and sense of ‘who you really are’ will likely come in place. Instead of thinking: if I could only change my body I could then change my mind and my perception of self-worth

would rise, it seemed as if she slowly began to look for her sense of self-value to improve from inside. As herself said, “unlike before, I am more accepting of me. I’ve learned to accept my body the way it is; embracing my curve, but at the same time as you taught me to work with this asymmetry from a place of compassion and understanding rather than opposition!” So given the right conditions, the mind and spirit gained the capacity to heal, allowing the body-mind’s natural healing mechanisms to flourish. That is what yoga therapy is really about. It is not primarily about fixing the issue rather is essentially about creating the conditions for self-correction and self-healing to occur. “The yoga concept of *vidya* (correct knowledge) creates a therapeutic environment that trains our insight to observe the parallel worlds of body, psychology, and spirit to help us uncover the ways in which we create meaning from our experiences while *tapas* fans the inner flame of awareness to help us recognize and change deeply held patterns of belief.”¹⁴

- Fostering Psychological Health and Spiritual Growth

Another reason for yoga’s feasibility as a therapeutic intervention is that its approach is all inclusive. In spite of the tremendous successes of technological approaches, our health care system generally neglected psychological and spiritual influences on healing. Among the spiritual aspects that yoga fosters are forgiveness, acceptance, gratitude, fulfillment, a sense of meaning, a lessening of suffering (*dukha*). Yoga suggests that suffering and pain are two different things. Pain can’t always be avoided but how much we suffer as a result depends on our state of mind. “Thoughts and emotional reactions to painful experience, yoga teaches, can fuel the fire of discontent and undermine healing. Learning to quiet the restless mind and tune into its tricks and habits is the path to transcending suffering.”² Virtually all of the practices within our plans were intended to nurture the above qualities and likely conferred such therapeutic benefits as enhanced self-regulation skills, in particular modulation of the stress response and emotion regulation. What’s more, overtime improved resilience and stress tolerance, emotional stability, positive attitude, and ultimately psychological self-efficacy did result. Not only our sessions provided her with healthy coping mechanisms for dealing with all kinds of difficulty (physical, mental, emotional), the awareness yoga has instilled in her helped correct some misconceptions she had internalized around her condition.

A primary way through which yoga can improve stress management and psychological well-being, researchers suggest, is improved self-regulation. The term self-regulation means “control [of oneself] by oneself”. It specifically denotes to the ability to oversee our automatic responses to life circumstances and to establish alternative thoughts and behaviors. As our capacity for self-regulation grows, so does our ability to regulate stress and negative emotions, enabling us to meet challenges with a greater sense of composure and balance. Researches suggest that yoga cultivates the capacity for self-regulation using a system-based network model that combines

both top-down and bottom-up forms of self-regulation.⁸ According to this model, specific yoga practices (ethics, postures, breath regulation, and meditation) suggestive of bottom-up mechanism affect self-regulation through bidirectional feedback loops that regulate cognition, emotions, behaviors, and peripheral physiology as well as through modulation of the autonomic nervous system in general, and the parasympathetic nervous system in particular. Top-down self-regulatory processes include control of intentional/motivational drive, working memory, attention, conscious intention, executive monitoring, response inhibition, and reappraisal. Such control signals include generation and maintenance of attention on the object of practice, which includes a continuous focus on an object of visual attention (e.g., point in space—dristi), aspect of the breath, or interoceptive feedback from body sensation or mental activity.

Yoga has also been shown to improve biological systems, including neurotransmitter systems, the HPA axis, and the immune system. The hypothalamic-pituitary-adrenal (HPA) axis represents the complex interaction among three major endocrine systems and influences many biological systems such as immunity and psychological wellbeing. Increased levels of gamma-aminobutyric acid (GABA), the brain's primary inhibitory neurotransmitter known to be significantly reduced in various clinical conditions such as depression and chronic back pain, has been associated with yoga-based practices and this may be one of the several mechanisms by which yoga may relieve back pain.

The sum of these mechanisms can serve to move individuals with scoliosis toward better health and functioning in general, as well as to facilitate improvements in their specific condition. Hence, it is highly encouraged to use yoga therapy as an adjunct form of support and long term therapy to clinical care of scoliosis due to its inherent potential for focusing less on a specific symptom or condition than on the overall effect on the person. Yoga therapy is a low-tech, relatively cost effective, versatile and generally very safe healthcare modality that has few unwanted and many desirable side effects and in cases of many back-related disorders can almost always be conducted in conjunction with medical care. It is recommended that the yoga therapist work as part of a multidisciplinary team including the orthopedic doctor, the physical therapist, the orthotist, and the mental health care provider - all are according to the International Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) guidelines and Scoliosis Research Society (SRS) philosophy. To date, scientific research has been published evaluating yoga for a number of back-related problems, including nonspecific low back pain (LBP), discogenic LBP, hyperkyphosis, and scoliosis. The amount and quality of the evidence varies from 12 trials with a total of 1221 patients for nonspecific LBP to a convenience sample of 25 consecutive patients with scoliosis from a single medical practice (plank pose). Taken together, these studies strongly suggest that yoga has an important role to play in the management of back problems for adults who are willing to practice yoga.¹

Encompassing all the information presented, we can clearly summarize that yoga therapeutic interventions can indeed provide an invaluable contribution to the management, alleviation of symptoms, potentially lessening the severity of scoliosis, and ultimately an enhanced sense of well-being by embodying a thoroughly integrated approach.

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