

Scoliosis and Proprioception

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Most types of scoliosis are classified as '**idiopathic scoliosis**' which means that the reasons for this type of rotational deformity of the spine are yet unknown. Nevertheless there are all kinds of assumptions, beliefs and anecdotal reports available in the alternative health community concerning the main causes and driving factors. For example the following factors have been suggested as causes : traumatic events (if birth trauma, then scoliosis is believed to start at the cranial end, if sexual trauma usually at the caudal end), visceral tensions (uncomplete embryological rotational movement of organs); psychological problems (not facing the world, making yourself smaller), unilateral psoas shortening, nutrition, the Coriolis force (which makes hurricanes and bath tap water to spiral in a counter-clockwise motion in the Northern hemisphere) and so on. Yet when applying usual scientific research standards, most of these claims have not been able to be substantiated, despite the fact that every year an impressive amount of money and research projects is devoted to improve our understanding of the causes of this dysfunction.

In preparation of my recent talk on 'Working with Scoliosis' at the Annual Rolfing Conference 2000, I did a **MEDLINE search** of published scientific research papers on this subject. While most of the papers are still on surgical and measuring techniques, there have also been a few hundred published studies in the last decade which concern the etiology and causative factors of this deformity. I will try to summarize some of the themes and findings here:

- Among identical twins the concordance rate for idiopathic scoliosis is about twice as high as among non-identical twins. This is seen as strong evidence for a **genetic predisposition**; although environmental factors seem to be involved too.

- Chicken whose pineal gland is cut away, develop scoliosis with very similar features to that of an idiopathic scoliosis in humans. Since the pineal gland produces only one hormone, **melatonin**, it had been suggested that melatonin deficiency could be a primary factor for scoliosis in humans (as well as in chicken). In January of this year a study was published that showed in fact a lower melatonin serum level in scoliotic patients than in a matched control group. Yet just a few months later a more careful study was published, which had been measuring the serum level throughout the whole day; and this study did not show any significant differences in the melatonin level of scoliotic patients compared with others. Also more recent studies with chicken showed that the induced scoliosis after pinealectomy has probably more to do with a secondary lack of serotonin (which has been known to influence general muscle tonus).
- Attempts to link idiopathic scoliosis with changes in genetic **collagen morphology**, or with zinc or potassium levels in the body have failed.
- Also no correlation could be found with the position or functioning of **visceral organs**. Except that in high-degree scoliosis the position of the aorta is changed. Yet this has been shown to be a secondary effect of the scoliosis, not related to a primary causative factor.
- Attempts to decrease the degree of scoliosis by cutting the **psoas** on the suspected 'short side' have failed. . This is also congruent to my own experiences in testing the myofascial length of the iliopsoas in the 'Thomas Test' manouever. My scoliotic clients seem to have 'on average' a similar myofascial length of the iliopsoas as other people.
- Histochemical analysis of the paravertebral muscles showed no myopathic changes. Flexibility studies of the lumbar spine, shoulder and hip joints showed no significant changes to a control group. This finding points to idiopathic scoliosis being an **organic rather than a systemic disease**.
- A computer aided biomechanical three-dimensional osseo-ligamentous model of the human thorax was constructed to explore how **asymmetric growth of the thorax** might initiate spinal lateral curvature and axial rotation as seen in idiopathic scoliosis. In fact their model showed that slightly larger ribs on

one side could result both in a sidebending convexity towards that side plus in an axial rotation of the spine similar to that observed clinically. *"The model supports the idea that growth asymmetry could initiate a small scoliosis during adolescence"*.

- An anatomical study of muscle biomechanics found that the *"spatial displacement of vertebrae in idiopathic scoliosis is not explicable by forces created by the muscles which act upon the spine only (intrinsic muscles). The **trapezius and latissimus** muscles are attached to the spinous processes and the upper limb". "The peculiarity of the vertebral anatomy, together with the direction of pull of these muscles, permits an explanation of the biomechanics of the development of 'idiopathic' scoliosis"*
- *"A 10-fold higher incidence of scoliosis was found in rhythmic gymnastic trainees (12%) than in their normal coevals (1.1%). Delay in menarche and generalized joint laxity are common in rhythmic gymnastic trainees". The study observed "a significant physical loading with the persistently repeated asymmetric stress on the growing spine" in these young gymnasts. A "**dangerous triad**" is attributed for the etiology of this type of idiopathic scoliosis: "generalized joint laxity, delayed maturity, and asymmetric spinal loading".*
- In general the morphology of scoliotic clients has **less mesomorphic** features. This seems to be also a predictive factor: if the mesomorphic values are low on the SHELDON typology, the scoliosis has a high probability to increase with age.
- The multifidus fibers tend to be more fast twitch than normal on the concave side of the apex (most likely as a result and not cause of the sidebending). **Myofascial release** work on the (shortened) concave side tissues yielded significant improvements in one study.
- Trunk rotation against resistance is usually weaker in one direction. A systematic **strength training** using a MedX Torso Rotation exercise machine, seemed to improve the degree of scoliosis in a recent study.
- MRI studies have shown significant proportion of abnormalities in the **brain stem** area (as well as in the spinal cord) among idiopathic scoliosis clients when compared with other types of spinal asymmetries or normal people.

- A significant correlation with otolith **vestibular dysfunction** could be shown. An interesting newer finding (which needs to be confirmed by others) is that people with hearing problems seem to be 'immunized' against idiopathic scoliosis; i.e. idiopathic scoliosis seems to be much more rare among them than in normal people. Which is seen as another indication for a strong neural factor in the etiology of scoliosis.
- Previous attempts to show a correlation between **handedness** and the direction of the primary curve had failed. Yet a newer study looked at the direction of convexity of the low thoracic spine regardless of the primary curvature. Their result: *"The correlation between scoliosis configuration and handedness was statistically significant. This is in contrast to the findings of previous studies, which have considered convexity only, without reference to the configuration of the whole spine. The implication of this finding is that scoliosis is associated with cortical functions"*.

This seems to be the **general trend** in scoliosis research: compared with previous years most of the newer research apparently explores the central nervous system as a primary causative factor. The study by Maguire et al on 'Abnormal Central Processing' (see article from Jerry Larson about it in this issue of ROLF LINES) is a typical example of it. It fits very nicely to another study, which I found even more intriguing, and which I will therefore choose for a more detailed description here. The study is called 'Proprioceptive Accuracy in Idiopathic Scoliosis' and was done by **W.Keesen** and others in the Netherlands. With the publisher's permission, let me quote from the original text and also add some commentaries from my side.

The article starts with: ***"Defects in proprioceptive postural control have been linked to the etiology of idiopathic scoliosis"***. Actually this has been found in several studies already since the early 80ies: that postural control – e.g.. walking on a high beam – tends to be less accurate in these people. Also the amplitude of their 'postural sway' – i.e. the balancing movements of the body in standing – has been found to be slightly larger than normal. Yet it was unclear whether that is the result or the cause of the spinal deformation.

The article goes on "*In particular a **rearrangement of the internal representation of the body has been proposed in these cases.***"

Now this sentence caught my personal interest, as I am quite fascinated in the correlations of outer body changes with specific dysfunctions in cortical body representation. In other words there is some evidence that the diminished postural control in these clients does not come from a less accurate motor execution but from a perceptual weakness based on an inaccurate 'body image' in their brain. Rolf Movement Practitioners, Feldenkrais Teachers, and other somatic practitioners involved with the internal body organization, this is your field!

The researchers then describe the following **experiment**: 200 patients were asked individually to sit in front of a table. The table had a visible grid consisting of 24 points on its upper surface. These 24 points corresponded with dome-shaped holes in the undersurface of the table platform. The experimenter would then place one index finger ('target finger') into one of the holes on the undersurface and asks the person to bring the index finger of the other hand ('searching finger') as close as possible to the target finger on the upper surface of the table, without being able to look under the table.

If you are sitting on a desk right now, try this out yourself. You will find out – even without a measuring grid as used in this experiment – that the accuracy of your searching finger is not perfect, i.e. it deviates from the position of the target finger by a few millimeters or even more. If you do this a couple a dozen times, you will quite likely find that when your right index finger is the 'searching finger' it tends to point too much towards the left, and vice versa. This phenomenon is described as 'overlap effect'. If you have a chance to compare your accuracy with that of a child or a teenager, you will also quite likely find, that you are slightly better than they. Which indicates that proprioception usually improves in life and might therefore be open for further improvement, e.g. through active facilitated learning.

Yet how do you guess was the finger accuracy in this test among the patients with scoliosis? The result of the study by Keesen et al was that there was a significant difference in the average accuracy

between scoliotic patients and others. In the language of the authors: "*In the present study, an inaccurate proprioceptive performance was ... established in patients with idiopathic scoliosis.*"

Now one could speculate, that maybe the spinal asymmetry was the cause of the inaccurate proprioception, rather than the other way around.. Yet the study reports that "*no correlation could be found between the degree of scoliosis and the magnitude of inaccuracy. In our view, it is not likely that the ability to bring both index fingers together is influenced to a great extent by a spinal deformity. If this were the case, we would be at the root of a new adverse effect of scoliosis, as yet unrecognized. However because the inaccuracy also is observed in subjects with a nonprogressive spinal asymmetry, which is often found in adolescence, the cybernetic defects in these subjects is more likely to be at the origin of a postural instability, which may, but not always, lead to idiopathic scoliosis.*"

How can a proprioceptive inaccuracy lead to a spinal deformation? Let me quote again the author's explanation: "*Hermann et al postulated that ... a sensory (proprioceptive) rearrangement or recalibration of the internal representation of the body in space is present, and that a **nonerect vertebral alignment may be erroneously perceived as straight.***" So when standing or moving in the upright position my body is in constant adjustments and oscillations to keep organized around a vertical axis in order not to lose balance. To do so we rely to a large degree on our internal perception of the alignment of our body in space (also called proprioception). If my thorax leans for example too much forward or to the right, my body will correct this automatically, i.e. without me having to pay conscious attention to these adjustments all the time. What happens in people with idiopathic scoliosis, is that they perceive and accept their body position as straight, when it is already slightly off center and when other people would continue to adjust and correct their balance. Over time – specially if this happens during the years of most skeletal growth – this could lead to an uneven usage and development of the osseoligamentous and muscular components of the spine and ribcage, such that their

habitual off-center position becomes the 'neutral position' and a straight position of the spine becomes difficult or strainful.

Now this reminds me of **similar distortions** of the internal body representation which influence the outer shape of the body. For example in anorexia it seems clear, that many of these skinny persons feel 'too fat' in their internal body perception. And therapeutic experience often shows that unless one succeeds in altering the **internal body perception**, curative attempts will be limited.

Another similar pattern has been described as 'anterior pelvic shift' or '**banana posture**' by Hans Flury. When standing these clients have their pelvis shifted (not necessarily tilted) anteriorly in relation to the thorax above. Flury attributes this to a chronic 'primary shortness' of the connective tissue on the posterior side. Yet in my experience I find also many clients in which this seems to be purely a 'postural habit' without any corresponding chronic tissue shortness as a cause. When lying on the table (on their side or any other position) or when floating in water there is no more banana posture. And when testing the overall myofascial length of the erector spinae according to Janda (in asking them to bend their head forward and downwards passively in sitting on a chair without changing their pelvis position), some of these people bring their forehead even closer towards their knees than their non-banana average competitors. In other words they only stand in such a banana posture, because in their internal perception this feels straight. When temporarily shifted into a more straight posture by a therapist from the outside, this feels to them as 'bent forward'.; and even if I ask them to concentrate consciously to carry their thorax more vertically over the pelvis, as soon as they shift their postural control back to the unconscious self regulation of every day life, they will return to their previous banana posture; not because of any tissues pulling them there, but because this feels 'straight' in their internal body organization.

Looked at this way, at least some of the cases of idiopathic scoliosis could have started the same way. Except that in their case it is not the sagittally oriented inaccurate proprioception which is the

problem, but the lateral 'banana deviation' of the spine, which is inaccurately perceived as straight.

Now that is where I suggest that **Rolf Movement** comes in handy. Try to correct a pure habitual sagittal banana posture with myofascial manipulation alone, without any postural education training, and you will most likely find only very limited or short lived results. Yet if treated with the wisdom and various tricks of Rolf Movement towards altering the internal body representation, it is often possible to achieve lasting results in as little as one session.

Let me therefore share with you how this research article by Keesen et al influenced my current work with idiopathic scoliosis. Besides myofascial work on the shortened tissues, besides encouraging them to build up a more healthy tonus in their trunk by an active healthy lifestyle, besides helping them to become 'a bigger person' physically and psychologically, and besides me cooperating actively with their other health care providers including their orthopedist, - besides all this, I involve them now more and more in exercises which **facilitate refinement in proprioception**.

One direction to do so are active **micromovements** of the client on the area of their body which I am working on. With proper coaching they learn to bring small undulations to even a single rib or vertebra at a time; without any spurious co-contractions somewhere else. Then even without my touching hand or elbow, they later learn to keep that sensory and motor refinement in sitting and standing.

Another direction is via all kinds of moderated **balancing refinements** in gravity. I usually start by Darrel Sanchez' *'Tuning Board'* in standing with open eyes, and having them notice their balancing habits plus various alternatives to that, with facilitated finer and finer perceptions. Then if they are ready, we can increase the level of complexity and stimulation, e.g. by having them close their eyes, by balancing a small cushion simultaneously on their head, by giving moderated 'earth quakes' to the board or gentle perturbations to their body with my hand from the outside, etc. Later they learn to balance sitting on a large ball without their feet touching the ground and by constantly adjusting their relative upper body position to the movements of the ball. Or they learn to squat

like a downhill ski racer on two 'wobble boards' (each foot on one half hemisphere platform). Additionally I encourage them to take up inline skating, snowboarding or similar hobby activities between sessions. Since most of the patients who come for scoliosis treatments are teenagers, this is often not that difficult, once a good rapport has been established. Often I give them the choice (I phrase it actually more as a 'requirement') to accompany my session either by weekly Pilates or Gyrotonix sessions or by taking up some kind of balancing sports activity like inline skating, etc. Some even start doing both, as these patients often have a high motivation and compliance.

If this sounds like fun and creative playful work, that is partly true. Yet no solid scoliosis (of 30 degrees Cobb angle and more) will be 'cured' by movement work and proprioception enhancement alone. At the most they can be powerful adjuncts for the much needed myofascial work. And as much as I don't like it myself, the use of a corset or even a surgical operation is often indicated in strongly developed cases if their history and situation shows signs towards further progression.

[Central nervous system processing in idiopathic scoliosis](#)

[Back to the article collection](#)

Central Nervous System Processing in Idiopathic Scoliosis

By Jerry Larson, M.A.

There are two kinds of scoliosis: neuromuscular (associated with a known neuromuscular disease like cerebral palsy or muscular dystrophy), and idiopathic. Idiopathic is a two-dollar word meaning, "we don't know why", and probably more than half of the cases are idiopathic. There are thousands of teenagers, and sometimes older adults, having major spinal surgery for correction of idiopathic scoliosis every year. I've been involved in a few of those surgeries myself.

There is an article in the journal Spine, "Intraoperative Long-Latency Reflex Activity in Idiopathic Scoliosis Demonstrates Abnormal Central Processing, a possible cause of idiopathic scoliosis" by Maguire and others, Spine vol. 18 #12, 1993, pp 1621-26. I'm going to quote most of the first paragraph, and then I'll translate. At the end I'll speculate about what this means for Feldenkrais workers and other bodyworkers.

"The clinical manifestations of idiopathic scoliosis are well known, yet its causes remain unclear. Several factors have been proposed, including abnormal structural elements of the spine, dysfunctional spinal musculature, genetic factors, alterations of collagen metabolism, and abnormalities of the central nervous system. The most promising investigations appear to implicate the central nervous system, especially those areas involved with postural equilibrium. Spinal cord reflexes play an integral role in the maintenance of posture. These complex polysynaptic segmental reflexes are regulated by a variety of descending suprasegmental systems, by peripheral afferent impulses and within the spinal cord by a network of interneurons and propriospinal neurons."

So, in other words, there is a great deal of complex interaction between different parts of the spinal cord involved in maintaining posture, including information from the peripheral nerves, from the brain, and interactions within the spinal cord. Messages from the brain fine-tune the process of postural regulation that goes on within the spinal cord ("efferent control system"). If you've ever studied the anatomy of the spinal musculature, you know that there are several

short muscles attached to each vertebra that can rotate it in different directions, which maintain the functional coupling of the vertebrae and determine how forces travel through the spine. Presumably this is how Feldenkrais and other bodymind modalities can have an effect on posture, walking, and spinal column function: through central mediation of the spinal reflexes, the central mediation being (somewhat at least) accessible to conscious control.

The article goes on to say that the abovementioned reflex activity can be measured electrically by recording EMG. They studied 37 cases of idiopathic scoliosis and 8 cases of neuromuscular scoliosis (three CP, three muscular dystrophy, and two other neuromuscular disorders) by recording late reflex activity during spinal surgery for correction of scoliosis. What they found was that **"long-latency complex polysynaptic activity" was present in all 37 patients with idiopathic scoliosis**, and absent in all 8 patients with nonidiopathic scoliosis. (These late reflexes are also unknown in normal subjects).

In other words, when you stimulate a nerve in the leg, you can record electrical responses from a muscle in the leg. You get an early response, say 5 milliseconds, by direct stimulation, and around 35 ms you get some later responses called H-reflexes and F-waves, which involve an impulse first going to the spinal cord and then bouncing back down the same nerve, or being relayed through a reflex arc in the spinal cord. In these idiopathic scoliosis patients ONLY, there are late responses ranging from 20 -243 ms in latency and lasting up to 4 seconds. It sounds to me like a ringing effect, a failure of damping. It's like a car with bad shocks, bouncing up and down long after you hit the bump, when the bouncing should have damped out quickly.

That means that there is some complex processing, involving lots of neurological connections and hence taking a relatively long time, in the idiopathic scoliosis patients. The best, and simplest, way to think of this is that something abnormal—something not seen in

normal subjects--showed up in the central nervous system processing of the idiopathic patients ONLY.

Now, I'd like to know more about that; I can think of criticisms, I'd like to see more of the waveforms, etc. If you're interested, you can look up the article in *Spine*, and they have lots of references. But assume they're correct. The conclusion is that "abnormal reflex processing may play a role in the development of the spinal deformity in patients with idiopathic scoliosis". This sounds somewhat like what Feldenkrais people have been saying all along, doesn't it?

Now, the abnormalities we're talking about are in the spinal cord, and we don't usually think of much learning going on in the spine, or even in the brainstem; we usually think of learning as happening in the cerebral cortex. So how can Feldenkrais work, or other bodyways, help with this kind of problem? Well, remember that there are "descending" impulses involved in the postural control mechanism of the spinal cord; in other words, higher centers can exert some degree of control over it. You can't operate your postural reflexes by conscious thought, but by practice, particularly by methods like tai chi, yoga, Feldenkrais, etc., you can possibly have a very beneficial influence on them.

It would be a little late to have a beneficial effect on this process when the person has already developed a life-threatening structural abnormality, maybe even had it corrected with multiple spinal fusions and instrumentation. However, by catching scoliosis early, and using bodymind methods like tai chi, Feldenkrais, etc., it might be possible to keep idiopathic scoliosis from developing into a serious problem. By the way, theoretically you could also use EMG biofeedback for this, but I don't know if it would be practical, since it might involve either inserting needles into muscles, or delivering electrical shocks while the person tries to modify the results of stimulation. Still, I refuse to say it's impossible.

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[Scoliosis and Proprioception](#)

[Back to the article collection](#)