

**Review Article**

Incobotulinum expedites Yoga's reversal of Adolescent Idiopathic Scoliosis

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Scoliosis is a three-dimensional curvature of the spine involving at least one curve to the right or the left that is greater than 10 degrees. Often the ribs migrate to the posterior of the convex side. Since the advent of vaccines for polio, and effective antibiotics for tuberculosis, over 90% of scoliosis is adolescent idiopathic scoliosis (AIS), meaning that it has no recognized general cause.

Our research appears to confirm one such generalizable factor in AIS: asymmetrical muscular tension on the spine. The concave side of thoracic or lumbar or thoracolumbar curve is thus the stronger side, contralateral to the convex side on which the ribs may bulge backward. We analyze "S" and inverted "S" curves into one lumbar curve and a contralateral thoracic curve and apply the same principle to each. It seems applicable to all these relatively unstable curves in adolescents and in older people whose curves tend to increase by approximately .75 degrees per annum [1].

We have now conducted five studies, mainly on patients with AIS, mainly of 12 – 20 years-of-age and published the findings five times [2-6]. One commentary on one of the studies, and my reply [4,7,8] have also appeared in the medical literature.

We have used isometric strengthening to restore or at least improve symmetrical muscular tension on the spine. The patients' work involves derivations of simple yoga poses, and rarely amounts to more than five minutes a day. We used *Vasisthasana*, the side plank pose, with the convex (weaker) side downward for lumbar scoliosis, *Ardha Chandrasana*, the half-moon pose with convex (weaker) side downward, and a belt connecting the concave side (horizontal) foot with the ipsilateral outstretched arm that pulls the foot forward for thoracic curves. We use both isometric poses for "S" or inverted-"S" curves. For thoracolumbar curves we use *Virabhadrasana II*, warrior

II pose with the convex side behind and a belt wrapped around the forward thigh that is pulled strongly upward by the outstretched arm of the concave side. Details and pictures are available in the referenced studies [2-6].

Patients were asked to stay in the pose(s) as long as possible, and to do them 3 times daily. They were cautioned that if their hearts started to beat irregularly, or they became light-headed or otherwise felt unwell, they should come down immediately. Young children's parents were asked to watch them do the pose both for safety and to be sure they were challenging the proper muscles.

All measurements were made on standard or EOS X-rays using the unmodified Cobb method. Statistical methods included Whitney-Mann, paired t-tests and *Chi* squared.

In 2014, Erik Groessl, Karen Sherman and I trained 25 patients [2] to do the side-plank for 90 consecutive seconds daily. The mean self-reported practice of the yoga pose was 1.5 minutes per day, 6.1 days per week, with mean follow-up X-rays at 6.8 months. Among all patients, a significant mean improvement in the Cobb angle of the primary scoliotic curve of 32.0% was found. Among 19 compliant patients, the mean improvement rose to 40.9%. Within this patient group, improvements did not differ significantly among adolescent idiopathic and degenerative subtypes (49.6% and 38.4%, respectively).

In 2017 Erik Groessl and I trained 74 people [3] with lumbar, thoracolumbar and thoracic AIS and degenerative scoliosis (DS) for a mean 7.1 months. The DS group improved 27.3%; the AIS group improved 34.2%. Lumbar and thoracic curve improvement was significant: $p < .001$ and $p = .004$, respectively.

The third study [4], in 2021, found 133 young and older patients⁴ with AIS and DS improved from a mean thoracic or thoracolumbar or thoracic curve of 49.4 degrees to 37.3 degrees or 24.5% in 10.75 months.

In the fourth study [5] (2024) we saw that we could do more than just strengthen the weak side to effectively equalize the muscular pull on the two sides of the spine. We could also temporarily weaken the stronger side of the spine with incobotulinum A neurotoxin injections, thereby integrating Western medicine with the yoga-like treatment described above. Patients' mean full day holding time in the side-plank was 155 seconds. Using this integrated approach, 56 patients improved from a mean 36.9 degrees to 26 degrees, or 29.5% in three months, $p < .0001$.

Our final study to date [6] (2025) narrowed the field to thirty 12 – 20 year-old patients with lumbar AIS. One control group did a sham yoga pose, a second control did the actual side plank with placebo injection. The intervention group did the side plank and received botulinum injections. We carefully monitored them at 3 weeks and 3 months following 3 injections of 33 IU of incobotulinum toxin A each into the concave side's quadratus lumborum and paraspinal musculature at the level of the curve's apex, and the iliopsoas muscle opposite L4, using EMG monitoring to be sure we were in the proper muscle in each case. Mean daily holding time in the side plank was 165 seconds.

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The yoga and incobotulinum group's mean curve descended from 33.2° to 24° in three weeks (27.7%), and to 21.1° (36.8%) at the end of three months. Both of these values were significant $P < .001$. In longer term, as yet unpublished follow-up, patients continue to improve at approximately the slower rates seen in the first three studies above.

Summary

In a total of 318 patients in these 5 studies, we have seen average improvement in thoracic and lumbar curves of 34.4% over an average of 6.3 months. Further details are found in the studies themselves referenced below [2-6]. Apart from temporary discomfort in the wrist and/or shoulder seen in two patients, no adverse side-effects were seen in these studies. One attempt to replicate our findings [7] with the side plank was negative, but careful review found that the study's randomization created an intervention group that did not contain any patients with lumbar curves, the type of scoliosis for which the side plank is used in our work. This criticism can be found in the journal's Letters to the Editor [8]. All this communication preceded our use of incobotulinum.

The perception that asymmetrical muscular tension is a significant factor in AIS and idiopathic scoliosis in general derives from the concept of tensegrity brought forth by the architect Buckminster Fuller. The guide wires of a tent pole, the inward leaning of a Roman arch, and Fuller's Geodesic Dome are examples of structures without rivets or glue or mortar, which are held together by tension between their parts. Our solar system is another example in which the invisible tether of gravity holds the familiar array of planets in relatively stable conformation as it hurdles through space. In the case of live creatures, these tensions are produced by muscles and therefore are quite variable, with conscious and non-conscious adjustments of many other muscles' tensions to generate leverage, retain balance and enhance poise.

Discussion

The isometric effort put forth by patients with lumbar scoliosis doing the side plank strengthens the quadratus lumborum, the paraspinal muscles including the multifidus, intertransversarii, iliocostalis lumborum, and the long and short rotatores. It also strengthens the serratus posterior inferior, and possibly most importantly, the psoas muscle. The contralateral incobotulinum injections naturally tend to reduce the resistance to straightening the spine, and by doing so allow the convex side muscles to shorten. Since muscles are strongest at their resting length, [9] this factor also helps equalize muscular tension on the two sides of the spine.

There are few drawbacks to these simple maneuvers. Unfortunately, with or without botulinum injections, they are unlikely to be effective in cerebral palsy, congenital anomalies or Pott's disease. We have devised work-around postures for special cases such as extreme weakness, rotator cuff syndrome and amputation.

If this procedure, with or without incobotulinum, proves of general benefit, it has distinct advantages:

1. Absence of confining braces, surgical risks, and inflexible post-surgical restrictions of movement.
2. An innocuous procedure such as this can be applied to small curves before they reach the size at which conventional treatment would be initiated.
3. It has very low cost and universal applicability.

The results above indicate that older people do not improve as quickly or as well as youngsters. One reason for this is the intransigent restraint of paraspinal ligaments, which, even in teen-agers requires orthopedic surgeons to use a powerful ratchet mechanism to straighten the spine during surgery for AIS.

We are now preparing to use relaxin, an antifibrotic placental hormone which loosens the pelvic symphysis before birth, as well as all other ligaments. We believe the temporary weakening of the concave side muscles with incobotulinum and the pervasive stretching of the isometric side plank can be combined with relaxin to rectify the curved spine more effectively.

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