

Molecular Underpinnings of Verticality

By Jose Augusto Menegatti, Certified Advanced Rolfer

For Rolfering® structural integration practitioners, the vertical alignment of the human body structure is the point of harmony and, indeed, of reference for the establishment of order. This may seem obvious to structural integrators, but where and how did this idea originate – and where is it going? I would like you to join me as I trace its development, incorporating thoughts of persons with different professional perspectives and from different periods of history.

There are varying degrees of approximation to vertical alignment in the structure of the living human body. In the illustration below, the first four figures from left to right are based on body grading charts developed by Goldthwait and others at Harvard University in the 1930s (discussed below). The bodies are rated as follows: A - excellent; B - good; C - weak; and D -

very weak. At far right, the body labeled E is the vertical body structure that Dr. Ida P. Rolf (Rolf 1977) put forward as ideal.

DR. JOEL E. GOLDTHWAIT

A key historical reference is the work performed at the start of the 20th century by physician and surgeon Joel E. Goldthwait and his colleagues at Harvard Medical School. Goldthwait's basic insight was the importance of teaching his patients how to stand, sit and move around while maintaining adequate vertical alignment. His thinking was based on observations during surgeries that nerves, veins and arteries were in a higher state of tension in patients whose body structures were out of vertical alignment. He concluded that many cardiac problems arose as a consequence of poor body mechanics, which distorted the organization of the thoracic cavity in a way

that compromised cardiovascular function. Similarly, using x-rays, he documented that calcium deposits around the vertebrae of arthritic patients diminished when the patients learned to maintain a more vertical posture.¹

DR. IDA P. ROLF

Dr. Rolf bequeathed to us the idea that the human being is organized around a polarized line. She proposed that our accommodation to the powerful gravitational field in which we live is made possible by continual adjustments of the responsive plastic tissues *derived from the mesoderm* – particularly by the capacity of these tissues to register and effect alterations in the vertical alignment of the body in response to certain types of stress.

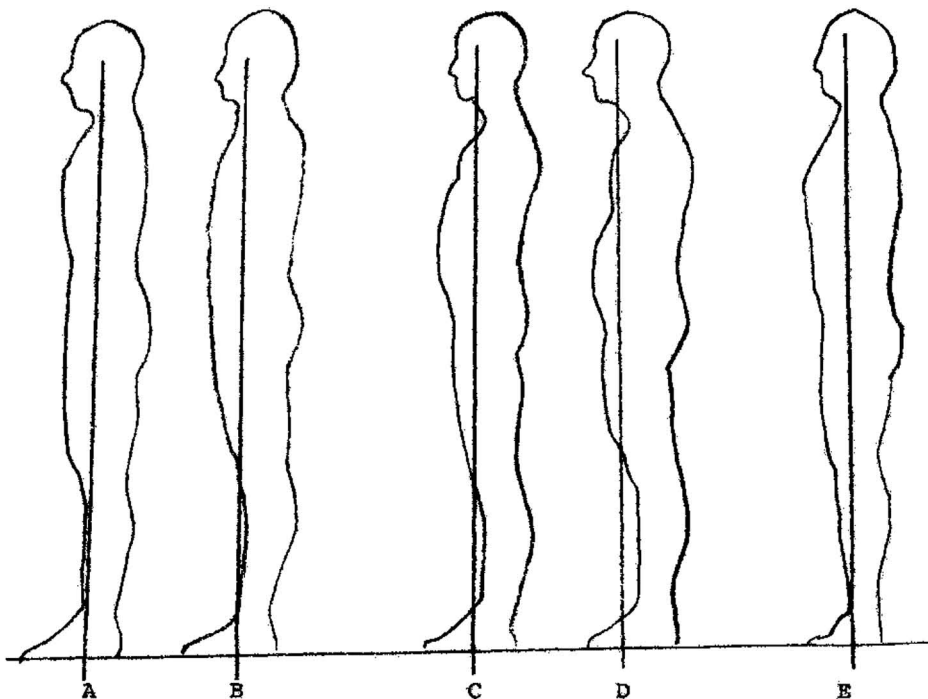
She also said that the Earth's powerful gravitational envelope – despite being subliminal to human consciousness – controls and drives us through its effects on the fascial system. However, she believed that if we could control and direct the behavior of this derivative of the mesoderm, we could also use gravity in a manner both beneficial and constructive. For her, human verticality was an ongoing evolutionary process – one that Rolfering practitioners could advance, thanks to the responsiveness and plasticity of the mesodermal tissues.²

DR. MAE-WAN HO

Based on accounts from the 18th and 19th centuries, as well as recent discoveries made in her own laboratory toward the end of the 20th century, Hong Kong biochemist Mae-Wan Ho³ took Ida Rolf's hypothesis of the plasticity of the human structure in response to gravity *beyond the mesodermal tissues*. She proposed that virtually all tissues in living organisms have such plasticity. Let's trace the developments that led her to this conclusion.

1899 – Biologist William Bate Hardy described the special physical properties of protoplasm (all cellular content), and classified it as a *colloid* – something that is neither a solid nor a liquid. Then, in 1927, he suggested that studying *the axes along which molecules orient themselves* might be important for understanding the nature of living protoplasm.

1929 – Biochemist Rudolph Albert Peters observed that among *liquid crystals* – i.e., substances with molecular densities between those of liquids and solids that



vary in response to changes in stimulus – axial molecular orientation is a universal property.

1936 – Histologist Joseph Needham proposed that the key characteristics of protoplasm could be understood in terms of liquid crystals. He suggested that liquid crystals are not important for biology and embryology because they manifest certain *properties* analogous to those of living systems – but because *living systems actually are liquid crystals*. However, there was no evidence to support this notion until Ho developed a technique to detect *biological liquid crystals*.⁴

WHAT ARE BIOLOGICAL LIQUID CRYSTALS?

How are liquid crystals defined and explained; and what is the difference between ordinary liquid crystals and biological liquid crystals?

Liquid crystals are substances that exhibit variable states of molecular order; i.e., their density varies as they are exposed to different stimuli. Each of us has handled some kind of gel – and liquid crystals are gel. Unlike liquids in which molecules are less ordered, in liquid crystals (as in any crystalline structure), the molecules are aligned in a common direction. However, liquid crystals are different from solid crystals because of their malleability, adaptability and responsiveness to a series of stimuli – *in the same way as the living human body*.

Biological liquid crystals share the characteristics described above, but differ from inorganic liquid crystals in that they are *autopoietic* – i.e., self-replicating.⁵ Their constituent molecules reproduce themselves continually as long as the organism is alive. Interestingly, it is now recognized that virtually all constituents of the living body – including lipids of cellular membranes; DNA in chromosomes; and possibly all proteins, especially cytoskeletal proteins, muscle proteins, and proteins in the connective tissues such as collagens and proteoglycans (macromolecules that are part protein and part carbohydrate) – are liquid crystals. These liquid crystal components can change their density when exposed to electrical and magnetic fields; alterations in temperature, pressure, pH, hydration, and the concentration of inorganic ions; and different frequencies of visible light. Note that *all these phenomena occur continually in the living human body*.

WHERE IS THE VERTICAL AXIS?

Unlike Rolf and Goldthwait, Ho does not propose any particular method to work with the structural organization of the human body. However, elements of her discoveries about living organisms and biological liquid crystals should be of interest to us – particularly with respect to the plasticity resulting from the variable states of molecular order in living organisms and the molecular orientation that directs the polymerization of biological tissues. According to Ho, all organisms – from protozoa to vertebrates, without exception – polarize along a specific axis. Higher animals polarize along the head-to-tail axis, which in humans is the vertical axis. In other words, the main axis of the body is also the principal axis of molecular orientation for the whole organism. Therefore, to all intents and purposes, the living organism is a uniaxial crystal. Maitland already noted this possibility.⁶ Oschman⁷ added the idea that intercommunication through the connective tissue network among the all the cells of the body might explain the superior fine motor coordination of human beings. Maybe liquid crystal body organization should be the dream of students of robotics; at a stroke, it might yield robots with fluid motor coordination and solve practically all a robot's structural problems!

FINAL CONSIDERATIONS

The idea that each living organism might be, on the molecular level, a biological liquid crystal is not universally recognized or accepted. However, it is an intriguing proposition – and, to me, an adequate one for now – to support a truly holistic and ecological vision of the human body's capacity to achieve increasing degrees of vertical organization and adapt to the same. To consider, therefore, that the plasticity of the human body structure arises from the inherent capacity of the living organism to alter states of molecular order in all of its constituents – and to accept that this plasticity is the factor that makes possible changes in the degree of structural order in relation to the vertical axis – leads us to a better understanding of how Rolfing might work.

The propositions and discoveries cited above suggest that we do not change tissue so much as supply appropriate stimulus to induce the organism to change itself. By modulating our touch, we induce changes

throughout the organism by virtue of the communicative properties of the connective-tissue network.

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3. Mae-Wan Ho obtained her Ph.D. in Biochemistry from Hong Kong University. She was a Postdoctoral Fellow in neurosciences at the University of California (San Diego); a Fellow of the U.S. National Genetics Foundation; and a Senior Research Fellow in Biochemistry at the University of London. Currently, she is a Reader Fellow in Biology at the Open University, UK, where she researches and teaches the physics of organisms and sustainable systems.
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