Yang Chengfu's Ten Essentials insured that the practice of Tai Chi Chuan would improve people's health. It is impossible to overstate the importance of these Ten Essentials in identifying the elements that make Tai Chi Chuan a healthful practice. Without the Ten Essentials, it is doubtful that Tai Chi Chuan would be recognized all over the world as a unique exercise system that offers special benefits to those who practice it.

LOOKING THROUGH THE LENS OF SCIENCE AT THE TEN ESSENTIALS OF TAI CHI CHUAN

PART 4

A series of essays by Holly Sweeney,
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PART I II

Looking at:
"Hang xiong ba bei", "Contain the chest and lift up the back"

This principle means that the chest must not be puffed out. If the chest is contained then the back is naturally 'pulled up'. (1)

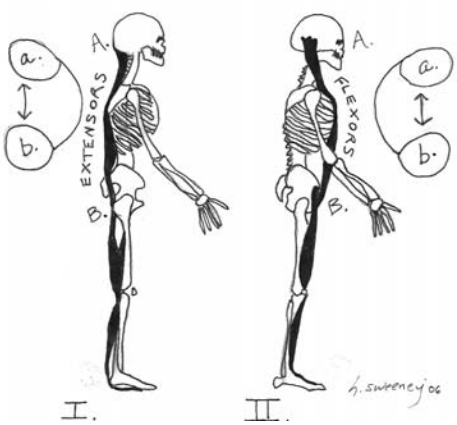
The science of biomechanics sees two advantages in 'containing the chest and lifting up the back'. One benefit is found in the overall organization of the musculoskeletal system and the other lies in the physiology of respiration.

In the previous essay of this series, (Part II, B, "Looking at Song yao, Loosen the waist"), it was established that the structure of our human body is based on the physics of tension. Our body structure is stabilized, supported, and moved by the action of our elastic tissues. This type of structure has a special name: it is called a "tensegrity" structure. (2)

Figure 1

If we look at Figure 1, a tracing made from a MRI of a living subject, we see how our vertebral column is suspended within the soft tissues of our bodies. We can also see that our vertebral column is comprised of a series of four curves; it is not straight like a pole. How much the curves are rounded depends on the actions of the elastic tissues that support our vertebral column. By shortening some muscles and stretching others, we can voluntarily make our vertebral column more curved or more straightened. As the lines of pull created by the action of muscles change the relative curvature of our spine, the tension created by the muscles is transmitted through the myofascial layers of our body to form continuous patterns of tension that give our body support and an external appearance which we call "posture". That is why each of us has a distinctive external appearance even though what is on the inside looks very similar. The way we distribute tension through our structure gives us a recognizable shape (posture) and way of moving (coordination) that is as unique as our finger print.

Figure 2



Looking at Figure 2, we see a diagram of the lines of tension that cover the back and front of our bodies. Figure 2, Diagram I shows the "pull lines" of the Extensor System on the back of our bodies and Figure 2, Diagram II shows the "pull lines" of the Flexor system on the front of our bodies. (3) (Muscle action of the Extensor System and the Flexor System differ at the knee and elbow joint from the myofascial action at these junctions. For the purpose of brevity and simplicity, we will not delve into this difference in this essay as it does not affect the topic under examination)

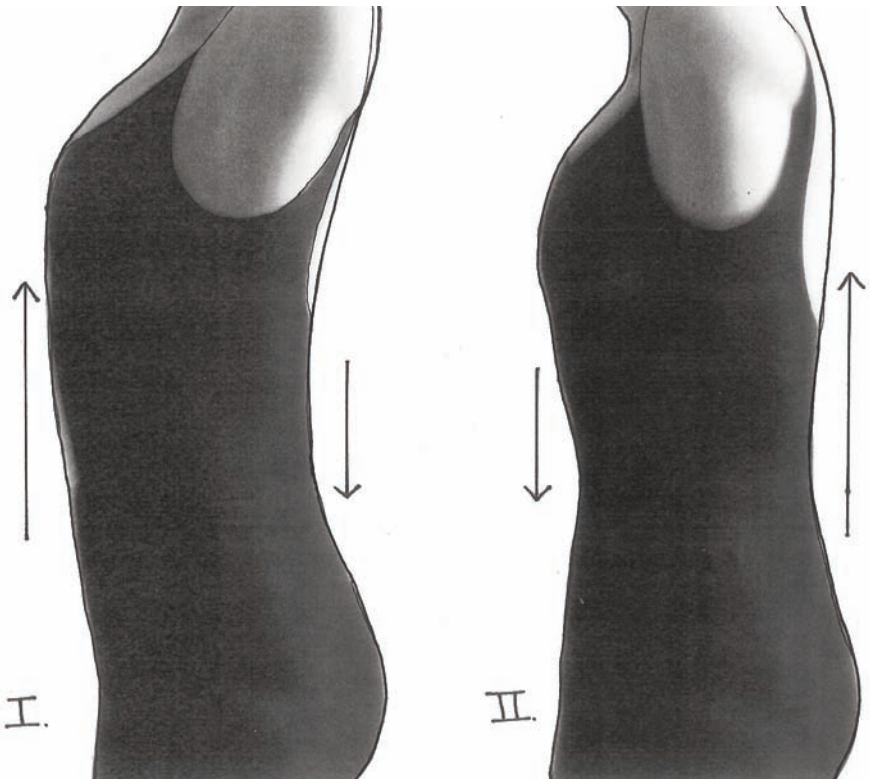
Each diagram is labeled with "A's" and "B's". In the Extensor System, the A is at the occipital ridge on the back of the skull and the B is located at the base of the pelvis. When the extensor system is shortened, the torso arches back. This is called "extension". If we try arching our back, pulling point A towards point B, we discover it is difficult to do and rather uncomfortable. Acrobats and gymnasts and skaters and dancers learn to arch their backs deeply after much training but the average person cannot arch very much. As we go into extension, the muscles in our backs tighten and shorten while the muscles in the front of our bodies stretch and elongate.

If we choose to go into "flexion", looking at Diagram II of Figure 2, we will pull point A, near our ear, towards point B, which is placed on the front of our pelvis at the pubic bone. This is much easier! We can curve our bodies deeply and easily in this direction. In fact, we were born that way, in flexion. When we go into flexion, the muscles in the front of our bodies shorten and the muscles in our backs lengthen.

This experiment, pulling point A toward point B, first in extension and then in flexion, reveals a huge difference in feeling when the extensors are called into action versus the flexors. That is because their basic construction is quite different. The extensor system is comprised of a very high proportion of slow-twitch endurance muscles with fibers running from head to tail. The primary job of these muscles is to keep us from curling over into flexion. Our ability to be upright rests solely on the function of these long, cable-like muscles, running from the base of the skull all the way to the base of the torso. The flexors have a very different composition. They are generally shorter muscles with fibers organized in many different directions and with higher proportion of fast-twitch fibers. They are capable of fast and complex articulations. If you've ever seen a belly dancer perform, you were probably amazed by the variety of movement the flexors can produce. In addition to producing fast and powerful movement, (think of a gymnast leaping into the air and somersaulting), the tensile strength of the flexors protect the organs of our abdominal cavity with a cross-hatched pattern of fibers designed to pull the abdominal wall in towards the center of our bodies.

In Figure 3, Photograph I, we see a woman with her arms raised above her head, shortening the extensors while the flexors are stretched. As a momentary coordination, it is OK with the

Figure 3



extensor and flexor systems to be called upon to lift up the chest and shorten the back. As a posture, it is NOT agreeable to the extensors and flexors. The extensors are very unhappy in this posture because they are not at resting length where they would be at their strongest and most energy conserving state. In their shortened state they will fatigue easily and start complaining loudly after they have become tired. The flexors aren't getting to do what they like to do either. As an ongoing posture, they do not like to be stretched. It makes them fatigue faster and undermines their job of supporting and protecting the abdominal viscera. (4)

Figure 4

In Part II, photograph II, we see the same woman with arms raised above her head, containing her chest and letting her back pull up. In this posture, the flexors are happy because they are toned with a line of pull toward body center, allowing the flexors to do their job of protecting and supporting the organs. The extensors are happy because they are extended to resting length where they have their greatest endurance and strength to resist the forward pull of the flexors.

The principle of "containing the chest and lifting up the back" gives us the posture our bodies are designed to maintain for optimal structural support with minimum fatigue. The posture created by applying this principle also benefits our breathing.

Figure 5

The biomechanics of breathing involve the parts of our structure that move air in and out of our lungs. The lungs can be expanded and contracted in two ways: one, by downward and upward movement of the diaphragm and, two, by elevation and depression of the ribs which increases and then decreases the diameter of the chest cavity. (5)

Normal breathing is accomplished almost entirely by the movement of the diaphragm. To breathe in, the muscles that control the position of the diaphragm contract and pull the diaphragm DOWN. Then, to breathe out, the diaphragm simply relaxes UP and the elastic recoil of the lung tissue, chest wall, and abdominal structures pushes the air out. In other words, only breathing in (inspiration) requires effort. Breathing out (expiration) happens without us having to do anything. Although, during heavy breathing, the elastic recoil is not powerful enough to expel the air fully, so extra force is achieved by contracting the abdominal muscles which push the abdominal contents up against the diaphragm to aid expiration. (6)

The second method for breathing is to raise and lower the ribs. Raising the ribs expands the lungs because, in natural resting position, the ribs slant downward, allowing the breastbone (sternum) to fall inward toward the spinal column. When the chest is "puffed out", the ribs are elevated and projected forward along with the breastbone. This makes the chest area about 20% bigger. After breathing in, the abdominal muscles have to pull the sternum and lower ribs down to expel the air. This method of breathing requires work during inspiration AND expiration. Sometimes we may need a little bit more chest capacity to expand our lungs. Opera singers and pearl divers are good vocational examples of the need for increased lung capacity. However, there is considerable cost in terms of energy for this type of breathing. For the extra 20% of capacity, we have to pay out as much as 50 fold more in muscle energy. For this reason, this type of breathing is best reserved for short term demand. (7)

We can conduct an experiment on ourselves to experience normal quiet breathing versus extra capacity breathing. Looking at Figure 4, we will puff out our chests to lift up our ribs to draw air into our lungs. We will keep one hand on our abdomen to feel what goes on there. We will discover that it is impossible to expel the air without forcibly contracting our abdominal muscles. If we copy Figure 5, keeping our chests contained, we will discover that we can expel air without contracting the abdominal muscles. After breathing in, if we just relax, our breath will flow out passively. This way of breathing, with our chests contained, is very energy efficient, using only about 3 – 5% of the total work energy our body expends to maintain itself.(8)

In conclusion, the principle of "Hang xiong ba bei", contain the chest and lift up the back, has a twofold benefit when examined through the lens of science. Both benefits have to do maximizing overall body performance while minimizing energy cost. Containing our chest and lifting up our back helps us maintain upright posture without fatigue. This principle also helps us breathe with great efficiency.

1. The Journal of the International Yang Style Tai Chi Chuan Association, #3, pg. 16.
2. Ibid. #19, pg 11.
3. Anatomy Trains, Thomas Myers. Pg. 60, 92.
4. Ibid. Pg 61, 93
5. Human Physiology and the Mechanisms of Disease, 5th Ed, Arthur Guyton. Pg. 282.
6. Ibid.
7. Ibid. Pg. 285.
8. Ibid