Fascia Science and Traditional Chinese Knowledge

Studying Tai Chi through Computer Models

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Overview

Clinical studies using various styles and teaching methods of Tai Chi have shown a wide range of health benefits. The common mechanisms for these benefits are not well understood. Traditional Chinese medicine, Chinese philosophy, and the Tàijíquán classics provide commonality for various Tai Chi styles.

Because Tai Chi emphasizes sōng (relaxation), fasciae may play a critical role in creating fluid and efficient movements. Fascial research has made progress identifying healthy fascia and methods to make it healthier. Additionally, biomechanics has developed various approaches to quantify fascia in motion, revealing how top-level performers utilize their fascia. The biomechanical concept of stretch stabilization plays an important role in Tai Chi.

The work presented here is intended to create a general approach for identifying the connections between Tai Chi and fascia by utilizing computer modeling methods. Initially, the study is focused on the factors involved in dynamic balance.

Simplified View of Fascia

Fascia fills the spaces in the body so that there can be movement along different anatomical structures and fluid exchange between them. These spaces spread throughout the body connecting different body components to form what has been recognized as another body organ, the interstitium.

Its structure consists of two collagen layers that connects to other structures with a viscous web between these layers that stretches and changes with movement. There are various components that exist in the fluid that fills this space along with nerves and blood vessels. The properties of this fluid varies in response to numerous factors. This in turn effects the quality (stiffness) of the fascia.

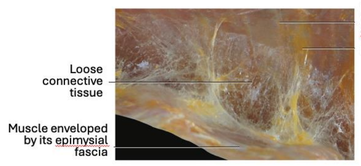


Fig. 1: Macroscopic aspect of the loose fascia between pectoralis major and minor muscles. The loose fascia creates a gliding surface between the two muscles and permits their independent contraction.

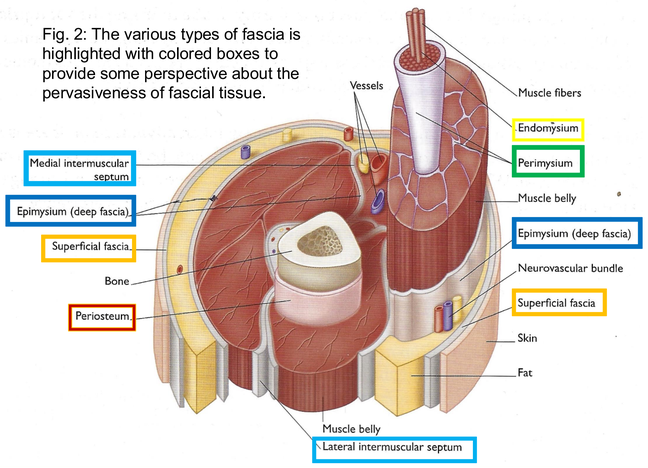


Fig. 2: The various types of fascia is highlighted with colored boxes to provide some perspective about the pervasiveness of fascial tissue.

Movement & Fascia

Fascia has many incredible properties including the ability to respond to both local, distal, and global changes. It helps immobilize joints in response to injuries. With training, it enables the performance of elite athletic. It provides a degree of hydraulic pressure for fluid movement through the body. It contain ions that carry charges. There is evidence the Chinese median system utilizes pathways within the fascia.

Traditional Tàijíquán Concepts

Tàijíquán has many different branches, styles, and derivatives. When looking at the literature about the benefits of Tai Chi, it is difficult to know whether the results apply to the full range of variations. Traditional Tàijíquán concepts are gradually developed as a practitioner advances in their Tai Chi training. It is not clear which concept might be most beneficial to a beginner or if more advanced concepts might provide even greater benefits.

The name Tàijíquán specifically indicates the original type of training with its martial arts connection and the inclusion of the principles in the Tàijíquán Classics. A few of these concepts are briefly presented here that may provide some insight to the mechanisms of how Tai Chi produces health benefits.

Tàijí (Yin and Yang)

Tàijí is not yin and yang existing as separate entities; rather, it is a single entity that binds yin and yang. ***Wang Zhongyue[1]***

Yin and yang describe two opposite qualities in traditional Chinese philosophy. They are not actually a strict quality of something; both only convey that quality in relationship to its opposite. They complement each other and have the seed to transform into the other so that yin becomes yang and yang becomes yin.

Sōng (Relax/Loosen)

As one progresses in Tai Chi, they are often told to relax the body. Relax is not the best translation for the Chinese word Sōng (松) which is used in the Tàijíquán Classics. Too often, it is interpreted as letting go of the muscle and collapsing like a rag.

An alternative translation is "loosen", where it means “let free to act”. Sōng can be explained as freeing the joints.

Fig. 3: On left is an untrained attempt at relaxing. While the picture on right incorporates the concept of song.

Fig. 4: On left is Yang Chengfu in the ward off posture. While the picture on right is Wang Peisheng doing the Wù style version.

Peng (Ward off/ Expand)

Peng describes a type of "trained force" and a movement used to train it. This force expands with upward and forward internal power (not muscles). The attribute of this force is soft and expansive. The effort should be sensed as barely enough.

Shén and Yì (Eyes and Mind)

These are higher level training that are found even in the basics. They are better translated as spirit and attention. The body responses differently when these qualities are utilized.

Fig. 5: On left, the practitioner is not looking in the direction of the movement. The left hand is lower than intended and the body has more of a twist to the right.

On right, the practitioner is doing a standard wù style brush knee form. His eyes are aligned with the movement.

External Integration (Whole Body Movement)

In Tai Chi, it is said that when one part of the body moves, the whole body moves. When one part is still the whole body is still.

This concept is sometimes deepened by considering the three external integrations. In this training, the movements (and “stillness”) of the limbs are made with each major joint in the upper limb, ”feeling” connected to its corresponding joint in the lower opposite limb. As examples of these feelings, the left shoulder is connected to the right hip, the left elbow is connected to the right knee, and the left hand is connected to the right foot.

Biomechanic Modeling for Tai Chi

To build computer models of how Tai Chi utilizes the body, a number of techniques are utilized. This is due to the complexity of doing calculations that need to eventual incorporate the whole body at a detailed level.

Traditional modeling of biomechanics

Standard models of movement utilize the concept of sticks (bones) and rubber bands (muscles). The rubber band connects the origin to insertion. When a muscle/tendon folds over a joint, a pulley is introduced to the model.

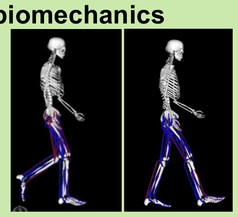


Fig 6: Standard model of walking structure generated in OpenSim

Newer types of computer models being utilized

Finite Element Analysis (FEA): Uses a mesh to approximate the structure and to calculate information at various parts of the mesh.

Flexible Body Analysis: Is a version of FEA that allows the mesh structure to change. These can also be used for fluid flows.

Multibody Dynamics Methods: Integrates rigid and flexible body components to reduce the computational demands.

Insight between Tàijíquán & Fascia

Many Tai Chi teachers utilize fascia research to explain various aspects of the art. These explanations are sometimes in conflict with each other and tend to lean on single aspects of Tai Chi and fascia. Still, this shows the power of fascial research that helps bring a deeper understanding of Tai Chi. These understandings can help teachers train beginners for more consistent health benefits and to reduce injuries that can occur in Tai Chi training.

I am not aware of much utilization of Tàijíquán principles to advance fascia research. This can only begin to happen as advancements in biomechanical measurements provide deeper insights into how Tai Chi manipulates the body. This requires studies done with advanced practitioners of the art.

Various aspects of fascial research

Anatomy Train model

Anatomy trains, also known as myofascial meridians, are intended to describe the pathways of functional force that travels through the body.

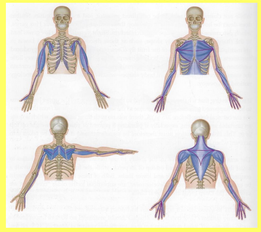


Fig. 7: Some lines of the anatomy train are shown here. The deep arm lines are shown on the left with front and back lines, the superficial arm lines are on the right

Biotensegrity model

The basic concept is for a healthy body, the bones float in a balance of tension created by the soft tissue.

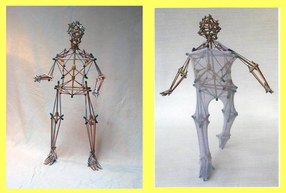


Fig. 8: Biotensegrity model that approximates the human body by Tom Flemons

Membrane Model

The fascia are membranes that intersect each others as they wrap around and fill the spaces in the body.

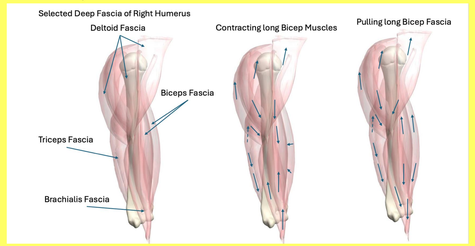


Fig. 10: Some of the epimysium fascia of the upper arm and their response as membrane due to a contraction of the long bicep muscle compared to a stretching of the muscle.

Hydrodynamic Model

The fluid of the fascia lies between two collagen layers that are connected by a ”webbing” of collagen fibers. The properties of this fluid varies, exerting different forces around the body influenced by numerous factors.

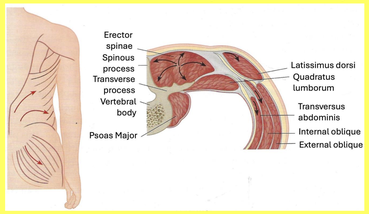


Fig. 9: When the gluteus fascia and latissimus dorsi contract, tension is created in the surrounding fascia pushing them out, which in turn creates matching force in underlying muscle that supports the hips and knee.

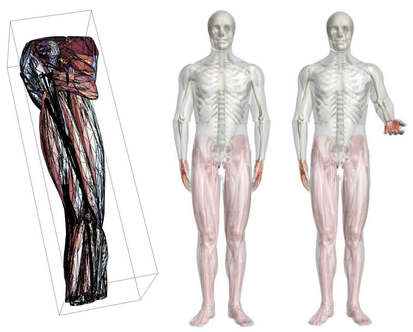
Balloon Model

The balloon model has several different variations of design and provides a simplified combination of a membrane with a hydrodynamic model.

Computer Modeling of Tai Chi

Part of the issue in modeling Tai Chi is that the whole body is active in the movement. The other issue is that it can’t be simplified to a traditional biomechanic model. This puts a large demand for the computations. The approach currently being developed is a hybrid of the various biomechanical models that have been proposed plus additional supplemental models as place holders for experiential qualities of tàijíquán and qi in the body.

The first models are focused on the elbows with simple connections to the rest of the body. The axial region is treated as a black box with the capability to transfer and supply forces to the appendicular region. The lower limbs are represented by the bones and the superficial fascia with simple models. The modeling is done in Mathematica utilizing its anatomy data.



These early models are looking at how sōng can benefit dynamic balance compared to utilizing muscle to maintain support. This utilizes a study of the potential responsiveness of the body to changes in the center of gravity under different assumptions.

A comparison is made of changes between a scenario where muscles are utilized to create a balanced structure and one where an opening of the joints and connection of the fascia tissue is utilized. This modeling still needs validation with biomechanical measures and considerations about the assumptions being used.

Fig. 11: On left, a mesh used for upper right arm. On right, Comparative computer models of different types of motions found in Tai Chi can be generated to study the impact of different variations of positions.

Conclusions

This work is only in a preliminary phase including extensive study in fascia research, initial proof of concept for the modeling portion, and initial findings from biomechanical studies. This is a new approach for modeling biomechanics with a focus on Tai Chi allowing insights that are beyond current research. This is expected because there are numerous observations in Tai Chi that don’t fit nicely in the current understanding of biomechanics and fascial research.

We hope to provide insights regarding differences between beginning and advanced Tai Chi that may lead to more consistent health benefits and reduce injuries.

Further Information

These QR codes link to a short presentation, the first by David Lesondak on fascia, and second, to a website with more details on the Tai Chi concepts, types of models, and the current models.

Primary Acknowledgement: Sources

Fig.1 - Stecco, C. (2014). *Functional Atlas of the Human Fascial System*

Fig. 2, 9- Earls, J. (2014). *Born to Walk*

Fig. 3,5 – Photos by Rebecca Sturnfield

Fig. 4 – Web image captures. Ai enhanced using Aienhancer.ai (see website QR Code for more info)

Fig. 6,10,11 – Mathematica models generated by James Sturnfield

Fig. 7, 8 – Lesondak, D. (2018). *Fascia: What it is and why it matters.*

1: Zhang Yun (2016). *The Taijiquan Classics.*