Biotensegrity,
a didactic tool for osteopathy

by Michèle Tarento
International Forum of Osteopathy - OsEAN
September 2021
Here is my CV which is on my website

Michèle Tarento,
• M.D., ENT, Phoniatrist,
• Osteopath,
• Lecturer in Histology and Embryology - CHU Bichat - Paris
• Osteo awareness® conceptor : (Body’s Physical and tensegral approach to optimize consciousness and adaptability)
• Practitioner in Bioenergetics (W. Reich, A. Lowen)
• Member of the Biotensegrity Interest Group (BIG) since 2011

www.osteo-eveil.fr
www.osteo eveil.com
michele.tarento@orange.fr
What is it about?

First of all, Biotensegrity

**a new vision of the dynamic architecture of the body**

which:
- overturns our traditional representations,
- uses innovative and scientifically validated models,
- and which, in addition, provides new keys to understand and perceive our osteopathic gestures.
My objective in the next 20’

I sincerely hope that this presentation will provide you with new answers to these fundamental questions that I have often asked myself as practitioner, passionated about research on posture and movement:

- How does the body adapt to different mechanical constraints?

- What allows the transfer of the osteopathic touch signal from its contact with the body to the nucleus of the cell?
My objective in the next 20’

and also :

- How, from the point of view of biotensegrity is the osteopathic lesion conceived?

- What are the different steps of the osteopathic treatment according to the light of biotensegrity?
So, what is tensegrity, what is biotensegrity?

**Tensegrity** is defined as a set of architectural and geometrical principles, derived from the observation of Nature.

**Biotensegrity** is the concept that applies the principles of tensegrity to living beings.
The structural principles observed in Nature and its dynamic organization, (closest packing, spirals) have led...
... Buckminster Fuller (1895-1983)  
architect, designer, inventor

- to give up 90° orthogonal reference systems,

- to give priority to triangulated networks in which all the elements are dynamically assembled at 60°,
Buckminster Fuller (1895-1983)

-and to integrate *Geodesic geometry*

in its construction designs.
After having laied down its essential principles in 1927 as follows:

*islands of compression in an ocean of tension,*

Buckminster Fuller coined the term *tensegrity* in 1950.
Kenneth Snelson (1927-2016) and the application of tensegrity principles

The impressive artistic tensegrity towers constructed by K. Snelson show the helical distribution of their internal forces.

The purpose of their constant reconfigurations in which mechanical and vibratory processes are associated is stability.
A tensegrity system is a system in a stable self-equilibrium state, comprising a discontinuous set of compressed components, inside a continuum of tensioned components.

René Motro, Professor and Researcher in Mechanics at the University of Montpellier (France)
Biotensegrity concept

Steve Levin, an orthopedic surgeon from Washington, D.C., coined this term in 1975. Inspired by the architectural dynamism of tensegrity constructions, he first applied it to macro scale and then, to micro scale of fascias.
Biotensegrity concept

Steve Levin, an orthopedic surgeon from Washington, D.C., coined this term in 1975. Inspired by the architectural dynamism of tensegrity constructions, he first applied it to macro scale and then, to micro scale of fascias.

- the discontinuous solid struts of tensegrity models find their equivalents in: bones.
- the continuous cables find their equivalents in: aponeuroses, ligaments and muscles.
Biotensegrity concept

Steve Levin, an orthopedic surgeon from Washington, D.C., coined this term in 1975. Inspired by **the architectural dynamism of tensegrity constructions**, he first applied it to macro scale and then, to micro scale of fascias.

- the discontinuous solid struts of tensegrity models find their equivalents in: bones.
- the continuous cables find their equivalents in: aponeuroses, ligaments and muscles.

In parallel, Donald Ingber, a researcher in biology at Harvard University, proposed the icosahedron as a model for the organization of the cytoskeleton.
Biotensegrity concept

Steve Levin, an orthopedic surgeon from Washington, D.C., coined this term in 1975. Inspired by the architectural dynamism of tensegrity constructions, he first applied it to the macro scale and then, until the micro scale of fascias.

- the discontinuous solid struts of tensegrity models find their equivalents in: bones.
- the continuous cables find their equivalents in: aponeuroses, ligaments and muscles.

In parallel, Donald Ingber, a researcher in biology at Harvard University, proposed the icosahedron as a model for the organization of the cytoskeleton.

- the discontinuous solid struts find their equivalents in: microtubules
- the continuous cables find their equivalents in: microfilaments and intermediate filaments.
What was decisive for these two researchers was their encounter with Kenneth Snelson's artistic Tensegrity Towers.

This confirms us the importance of reciprocal research interactions between Arts and Sciences.
After having asked engineers to make calculations, Steve Levin showed that the fascial network of the body is a dynamic triangulated system, inside which the constraints are constantly redistributed and balanced between the rigid elements (bones) and the flexible elements (and reciprocally).

Regarding the spine, it is not the facet joints that bear the stresses, but rather the architectural organization between the rigid and flexible fascias that constantly orchestrates the distribution and balancing of the loads throughout the structure.

Donald Ingber who applied the principles of tensegrity to the cells, has offered us a new approach to mechano-transduction.

For him living cells are similar to tensegrity icosahedrons: and their response to constraints gives rise to a mechanical deformation.

Transported from the ECM and redistributed by cytoskeletal elements from the cell surface to the nucleus, this mechanical deformation (=information) triggers metabolic processes.

Figure 9: Le cytosquelette cellulaire, la M.E.C. et la lame basale

M. Tarento drawing after: Construire son corps avec l’ostéo éveil et la biotenségrité- Sully 2016

After D. Ingber
...'Any deformation applied to the surface of the cell is immediately followed by a reorganization of all the elements of the cytoskeleton'.

D. Ingber
...It is the self-constraint of the whole body that allows the transfer of the signal over long distances (from the skin to the heart of the cell).

D. Ingber

This allows us to better understand our osteopathic touch dynamism.
and by making quantitative measures with Fourier spectrum analyzers, they showed that the matrix has oscillatory frequencies.
Biotensegrity concept

*The vibratory information is transferred through the tensegrity matrix, which acts as a coupled harmonic oscillator, transducing the signal from the cell periphery to the nucleus and ultimately to the DNA.*

Pienta K.J. and Coffey D.S. « Cellular harmonic information transfer through a tissue tensegrity matrix system ». *Medical hypotheses* - 34 (1) - 88-95, 1991
Thus,

the dynamism of living organisms is correlated to:

1- intrinsic synergetic tenso-compressionnall forces,
   = Mechanical processes expressed by Expansion and Retraction.

2- helical organization of the elements of the structure,
   = Vibratory processes expressed by Winding and Unwinding.
Biotensegrity: new keys to understand the complexity of life

We will see successively:
- Tension and compression
- Self-stress
- Heterarchy
- Non-linear elastic behavior
- Bones, powerful accumulators and distributors of kinetic energy
- Intertransformability in dynamic geometry

Two aspects are not developed due to lack of time:
- Unpredictability according to synergetics (B. Fuller)
- Auxetism
Tension and compression

These 2 opposit synergetic forces:
1- organize the internal spaces and create omnidirectional volumes.

2- generate self-stress which gives its dynamism to the systems, in particular, their reactivity to the constraints.
Tenso-Compressional Synergy is a constant asset of the human body:

- it underlies pneumatic spheres in its frame of reference.

and

- it is present from the first fertilized cell.
Biotensegrity: new keys to understand the complexity of life

Self stress

Self-stress is the consequence of:

- Tenso-compressional assembly modes at the tissue scale and at the cellular scale

- Hydrostatic pressure, Osmotic pressure

- Turgor effect
Biotensegrity: new keys to understand the complexity of life

Self-stress is generated by the assembly of microfibrils with microvacuoles and the scientific works of J-C Guimberteau show that.

The microvacuoles are pneumatic systems which provide a lot of micro-supports that allow the body to resist mechanical stress (while the microfibrills redistribute this stress to the entire structure).
Self-stress is the cause of:

- reactivity of the all body's systems which allows:
  - very rapid transmission of informations (mechanical and vibratory)
  - and permanent self-regulation of the structure.
Biotensegrity: new keys to understand the complexity of life

Heterarchy of structures

It is defined by the capacity for an organism to self-reproduce its mode of architectural organization, at all its scales.
Biotensegrity: new keys to understand the complexity of life

Heterarchy of structures

It is defined by the capacity for an organism to self-reproduce its mode of architectural organization, at all its scales.

The body is considered as a whole with subsystems that are interconnected and interact with even smaller systems; and each of them uses its tensegrity architecture to stabilize the structure through permanent rebalancing...

Illustration: Steve Levin d’après B. Fuller
Biotensegrity: new keys to understand the complexity of life

Heterarchy of structures

This allows osteopaths to understand better that any restriction of mobility or rigidification of one part of a system will have an impact on all the systems and sub-systems.
Biotensegrity: new keys to understand the complexity of life

Non-linear elastic behavior

The non-linear elastic behavior of biological structures is a physical manifestation of their tensegrity, that’s to say: of their synergetic opposit tension-compression forces. and it is important to get used to their perception.

The J curve: under stress, in a first time, the deformation is very important; in a second time the deformation is less important while the system stiffens.

Gordon J.E. Structures or why things don’t fall. Penguin books, 1978
Biotensegrity: new keys to understand the complexity of life

Non-linear elastic behavior

The understanding the J-curve invites us to address the tenso-compressionnial reactivity of the structure during our osteopathic manual practices.

Getting in touch with the tenso-compressionnial reactivity:

- gives us a status of the physicality of the structure: rigidity, density.
- allows us to evaluate the adaptability and comfort in the posture.
When comparing the energy accumulated in bone under stress (surface in red dots) with that of collagen (surface in hatched lines), we can see that the energy accumulated in bone is much more important.
Biotensegrity: new keys to understand the complexity of life

**Bones are powerful accumulators and distributors of kinetic energy.**

Bones are fountains of energy» S. Levin

This strongly encourages us to systematically address the bones (rigidified fascias) during our osteopathic practices:

and it is what I do in my personal research in osteo-awareness® and biotensegrity (www.osteo-eveil.fr).

- Levin S.M. « L’os est du fascia ». traduit par Tarento M. et Néplaz I. Site d’ostéo4 pattes, mai 2019
- Tarento M. Construire son corps avec l’ostéo éveil et la biotenségrité - Sully -2016
- Tarento M. « La tenségrité, la biotenségrité et l’Ostéopathie » - Revue du Site d’ostéo4 pattes Hors série N° 1-3 Avril 2018
- Tarento M. Biotenségrité, Fascias, Ostéopathie vers une perception consciente de l’architecture dynamique du corps – Sully, 2021
Biotensegrity: new keys to understand
the complexity of life

Inter-transformability" in dynamic geometry

The jitterburg is a geometric transformation process.
Biotensegrity: new keys to understand the complexity of life

Inter-transformability" in dynamic geometry

This process resonates with the changes of phase (gel-sol) of soft matters: colloids, polymers, liquid crystals, glandular secretions, etc., which occur under the effect of mechanical, thermal, piezoelectric or electromagnetic constraints. These changes of phase are reversible.
Action and perception in osteopathy, in the light of Biotensegrity

We will see successively:

- Fascial architecture, homeostasis and self-healing processes
- The osteopathic lesion
- Osteopathic treatment
Fascial architecture, homeostasis and self-healing processes

AT Still (1828-1917), founder of osteopathy, put the architecture of the whole fascial system and the perception of its continuum in the hands of his successors to establish their diagnosis and their treatment.

Fascial architecture, homeostasis and self-healing processes

AT Still (1828-1917), founder of osteopathy, put the architecture of the whole fascial system and the perception of its continuum in the hands of his successors to establish their diagnosis and their treatment.

For AT Still, the laws of Nature has to be respected otherwise the processes of auto-regulation (homeostasis) which lead to self-healing will be impeded.
Fascial architecture, homeostasis and self-healing processes

AT Still (1828-1917), founder of osteopathy, put the architecture of the whole fascial system and the perception of its continuum in the hands of his successors to establish their diagnosis and their treatment.

For AT Still, the laws of Nature had to be respected otherwise the processes of auto-regulation (homeostasis) which lead to self-healing would be impeded.

Convinced with the vitalist conceptions of his time, he said about the 'primary lesion':

*Find it, fix it, and leave it alone: Nature will do the rest.*

Osteopathic lesion

According to AT Still:

Osteopathic lesion called today ‘somatic dysfunction' is the partial or total interruption of the free flow in tissues; and the modifications of the tissue permeability (densifications, rigidifications...) involves gradual dysfunctions.
Osteopathic lesion

According to AT Still:

- **Osteopathic lesion** called today *somatic dysfunction* is the partial or total interruption of the free *flow* in tissues. And the modifications of the tissue permeability (densifications, rigidifications...) involves gradual dysfunctions.

- The word *flow* includes everything that is conveyed mechanically, neurologically, fluidically (by blood vessels, lymphatic vessels, interstitial liquids) and which participates in the vital principle and in the maintenance of health.
Osteopathic lesion

From the point of view of Biotensegrity:

‘Osteopathic lesion’ could be defined by organizational disorders in which altered patterns of tenso-compressional forces distribution are accompanied by inappropriate changes that occur in the flow of information and in homeostatic responses.
Whatever osteopathic treatment we perform (structural, functional), we apply a constraint (pressure, stretching) to the body, which induces a deformation.

Mégret J.F. « La tenségrité, vers une biomécanique ostéopathique -Mémoire d’ostéopathie »- 2003
Deformation
= Information

Divergent distribution throughout the fascial network up to the ECM

'Immediate' rebalancing of all the systems and sub-systems up to the nucleus of the cell

Reactivation of metabolic activities aimed at maintaining the stability of the internal environment (homeostasis)

Self healing process
Recoil is used to tissues strong rigidity.

in:

a-Self Adjusting Technique (SAT)
by Tom Dummer and Parnel Bradbury
and in:
b-Mechanical Link by Paul Chauffour and Eric Prat.

The practitioner applies a pressure (deformation) that leads him to reach the tissue barrier that is located at the beginning of the verticalization of the curve and it is where the recoil will be carried out.
Let us now share 3 recent testimonies about biotensegrity from French osteopaths
For Ildiko Somody Néplaz, osteopath, teacher and recently member of the BIG, 
*biotensegrity scientifically enlightens my osteopathic touch whose message spreads
to the cell. Biotensegrity as integrated into Michèle Tarento’s «osteo- awareness»,
idens my ajustements possibilities, giving back to the bone its essential role.*
Personal communication  2021

For Bernard Schmidt, osteopath, teacher, *biotensegrity is a new science of systems'*
- Conference at compared Osteopathy Meeting- 2021

For André Ratio, osteopath, founder and director of the CSO, Toulouse, Nanterre,
*this concept appears as a real opportunity offered to our senses, especially to touch,
to support our perceptions and gestures.*
Ratio A.  *Utopias - From the perineum to the brain, through the breath and the hand.* Editions André Ratio, 2018
However, a particular attention to the dynamic organization of the living matter awakens inside ourself...
...this image of Kenneth Snelson practicing the art of tenso-compressional adjustments of one of its sculptures...
...invites us to address both flexible fascias as well as rigid fascias that are the bones, in order to restore the optimal completeness of its dynamism to the fascial architecture.
Thank you to Ildiko Somody Néplaz for her very careful proofreading.

Thank you for your attention.

My deepest gratitude to Steve Levin.
Bibliography

- Abhsera A. « Maladies de l’os ou les os de la maladie »-Apostill N9 -2001
- Cummings C.H. « A tensegrity model for osteopathy in the Cranial field » -1994
- Fleury V. Les tourbillons de la Vie-Une simple histoire de nos origines. Fayard, 2017
- Gehin A. Concept de tenségrité en ostéopathie-Sauramp médical- 2010
- Gordon J.E. Structures or why things don’t fall- Penguin science-1978
- Levin S.M. « Continuous tension, discontinuous compression, a model for biomechanical support of the body » - Bulletin of Structural Integration, Rolf Institute, Bolder-31- 33- Bulletin of Structural Integration – 1982
- Levin S.M. L’os est du fascia. traduit par Tarento M. et Néplaz I. -Site d'Ostéo4pattes, mai 2019
- Martin D.-C. Biotenségrité -interplay of tension and compression in the body- Munich- Kiener press -2016
- Mégret J.F. « La tenségrité, vers une biomécanique ostéopathique »-Mémoire d’ostéopathie- 2003
- Paoletti S. Les fascias-Rôle des tissus dans la mécanique humaine-Sully 2003
- Plüger C. « The meaning of tensegrity principles for osteopathic Medecine »- Master Thesis 2008
- Ratio A. Utopies- Editions André Ratio- 2018
- Scarr G. Biotenségrité La base structurelle de la vie -seconde édition- Sully, 2020
- Still A.T. Philosophie de l’ostéopathie- traduit par P. Tricot- Sully-199
- Tarento M. « L’os, un fascia solide, un biomatériau interpellant »- Revue EPS – avril mai 2013
- Tarento M. Construire son corps avec l’ostéo éveil et la biotenségrité- Sully -2016
- Tarento M. La tenségrité, la biotenségrité et l’Ostéopathie »-Revue du Site de l’Ostéopathie- L’ostéo 4 Pattes- Hors série N° 1-3 Avril 2018
- Tarento M. Biotenségrité, Fascias, Ostéopathie vers une perception consciente de l’architecture dynamique du corps -Sully- août 2021
- Zorn A. Ph D « Physical thoughts about Structure - The elasticity of fascia »-Yearbook-2008
Kenneth Snelson: www.kennethsnelson.net/sculptures
Steve Levin: www.biotensegrity.com
Jean-Claude Guimberteau : www.endovivo.com
Michèle Tarento : www.osteo-eveil.fr
Graham Scarr: www.tensegrityinbiology.co.uk

Sessions de construction de modèles en langue française :
dc_martin@gmx.de