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THE HUMAN MONOCORDE

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ABSTRACT

An analogy between osteopathic treatments and playing the guitar is presented by using and comparing the physical elements of both activities. The complex brain-spinal cord and filum terminale is compared to the string of a guitar and the human emotions are compared to the music being played by such an instrument. Undulatory movements are present in the cosmos in the human movements as well as in the guitar music. They constitute a display of universal entropy.

KEYWORDS

Spinal cord, filum terminale, medullary traction force, music, movement, entropy

CORRESPONDANCE

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"Let empty ourselves, let's be roseaux, harps, membranes, resonant conques, let's become instruments so that music can flow through us as we are all musicians with an personal melody to show"

Gabriel Rosales (1)

The primitive human being discovered that a sound was being produced when using his hunting bow, soon he improved this sound by adding a hollow calabasse or a turtle shell to the extremity of his bow. In doing so, he created a very simple string musical instrument.

We describe here some analogies between music, harmony and melody of the guitar and of the human being.

THE SPINAL CORD, A STRUCTURAL AND MECHANICAL ELEMENT

Natural selection ensures that the genes of the most energy productive organisms are transmitted to future generations. Because of this, individuals whose body tissues and organs are able to perform simultaneously the greatest amount of biological functions, will benefit from the best reproductive success. For instance, bones from the lower extremities are concomitantly involved in gait, erythrocytes formation and are used as calcium reservoirs. The structure of the central nervous system (CNS) is no exception to this rule.

Until now the spinal cord was described as an anatomical structure composed of neurons and other cells of ectodermal origin, whose principal function was the production, transmission and integration of nervous impulses. As we discovered the existence of the traction medullary force (TMF) we added an anatomical, structural and mechanical function to the spinal cord. The cerebral hemispheres, the medulla oblongata, the cerebellum, the cord and the filum terminale constitute a very compact unit. This unit is under tension, the TMF which is transmitted from the periosteum of the skull (dura mater) to the sacral insertion of the filum terminale. This unit is also one of the longest structural elements of the human body.

Several authors have reported other forces acting on the longitudinal axis of the human body. Amongst these tensions there are fascial and skin tensions and tensions from muscular chains (particularly the posterior chain). There are also tensions due osteo-ligamentous links of the vertebral column and of the dura mater. None of these forces predominate since they complement each other and have a collective action. At present osteopathic treatment address the different body structures separately, for instance muscular chains and joints are treated with articulatory techniques whereas the dura mater is addressed via cranio-sacral techniques, etc. In this article our prime focus is the specific tension of the spinal cord, the traction medullary force (TMF).

A raise of the TMF above normal values has clinical consequences on the structure of the vertebral column and on the physiology of the nervous system (2) (3) (4) (5) (6).

THE CRANIO-SACRAL SYSTEM AND ITS SIMILARITY WITH THE SPANISH CLASSICAL GUITAR.

An analogy can be made between the neural axis complex (brain-spinal cord and filum terminale) within the human vertebral column and a string musical instrument the monocord

The guitar string follows a free pathway from its insertion in the cheville to its anchorage on the harmony table?. This is reminiscent of the insertions of the cerebral mass within the skull and the free path of the spinal cord within the spinal canal to its insertions on the sacrum via a taut cord, the filum terminale.

Classic anatomy books represent the spinal cord as being centred within the spinal canal and at equal distance from the bony contour of the vertebral column and from the dura mater. Such anatomy drawings were made from cadavers studies and they conditioned our interpretation and understanding of the physiology and anatomy of the vertebral column.

However on MRI sagittal sections of the vertebral column "in vivo", the spinal cord cannot be centred within the spinal canal but follows the straightest path between the curves extremities. Such configuration reminds us of the string of the hunting bow and of primitive string instruments. In the lumbar curve the spinal cord is in contact with the posterior aspect of the vertebrae, whereas in the dorsal region it touches the anterior part of the spinal canal.

The dura mater follows spinal curves which demonstrates a lesser tension than the spinal cord.

THE ANATOMY OF THE HUMAN MONOCORDE

Here follows the description in a descending fashion of the elements composing the Spanish classical guitar and its equivalents in the human body. The terminology used is from the book of Gabriel Rosales on the Spanish classical guitar (8) (9).

1a) The strings of the guitar and the tuning of their tension. Until mid XX century the strings were from animal origin. The sound of the guitar depends on the degree of tension of its strings. Fine tuning of the tension is accomplished by turning the keys located at one of the extremities of the string. When struck with the finger, the cord gets deformed and vibrates when it returns to its original state which produces the sound. The greater the tension of the cord the greater the fundamental key will be. Very strong striking can produce such strong vibration that they will damage the cords.

1b) The spinal cord and its variations in the medullary traction force (MTF). The spinal cord has its own tension, the medullary traction force (MTF), this is an element of vertebral cohesion within the spinal canal. The MTF is produced by the difference of length existing from the 3rd months of embryological development between the vertebral column (which acts as a containing structure) and the neural axis (which acts as the contained structure) (10). Any tensions produced in this area can lead to temporary or permanent variations in the MTF.

If an overloading of tension occurs it may create mechanical or functional dysfunctions. Yamada (11) has shown in cats experiments that traction on the filum terminale of about 1 gr did not lead to any metabolic changes in the nervous tissues of the lumbo-sacral cord. Traction of 2 to 4 gr produced potential variations in OE, redox, mitochondrial of the nervous cell, perturbation of the bioelectrical potential and a decrease of the interstitial circulation of the nervous tissue. Tensions of 5 gr stopped the bioelectrical activity and the interstitial circulation producing an ischemia and the death of the nervous cell of the lumbo-sacral medullary tissue. This means that

any mechanical action on the structure of the spinal cord produces variation in the TMF and has a direct action on its function, the metabolism of the CNS.

2a)

2b) **The human head.** It is the most distal part of the human body. The skull is the bony structure of the head within which the brain, the cerebellum and the medulla oblongata are enveloped by the meninges.

3a) **The guitar chevillier (six keys).** In the Spanish guitar there are six keys.

Keys have a serrated mechanism through which the strings tension can be increased or decreased so that the guitar can be tuned.

3b) **Insertions of the dura mater in six cranial bones.** According to Sutherland and some other osteopaths, the cranium is flexible due to specific arrangement of its serrated sutures. The dura mater is the most resistant of the meninges and acts as a periosteum on the internal surface of the bones of the cranium fixing the cephalic mass. This fixing action is helped by the folds of the dura mater, the falx cerebri, the falx cerebelli and the tentorium cerebelli, which transmit the MTF to the cranial bones:

1. To the ethmoid at the level of the crista galli, through the falx cerebri
2. To the sphenoid, at the level of the posterior clinoid processes, through the extremities of the tentorium cerebelli
3. To the temporals through the laterals insertions of the tentorium cerebelli
4. To the frontals at the level of the metopic suture, through the insertions of the falx cerebri
5. To the parietals at the level of the sagittal suture, through the insertion of the falx cerebri
6. To the occiput at the level of the internal occipital crest, through the insertion of the falx cerebelli

4a)

4b) **"Foramen magnum".** It is located in the inferior part of the cranium, in the occipital bone. The spinal cord passes through it. The dura mater inserts on this foramen and on the first cervical vertebrae then descends freely onto its sacral insertion. A widening or a narrowing of the diameter of the foramen magnum can produce diverse pathologies. Crepitus and spontaneous clicks in the cervical joints are frequent in people presenting with tensions at the base of the skull.

5a)

5b) **The cervico-thoracic column and its nineteen vertebrae.** The vertebral column is not straight but curved (concave and convex). Through the vertebral column passes the spinal cord which conveys numerous motor and somatosensory informations. The vertebrae are bony structures. The cervico-thoracic column is made of nineteen vertebrae, 7 cervical and 12 thoracic. Following an injury or in case of fracture, osteoporosis or arthritic degeneration the distance between each vertebra may vary. If the vertebra present with osteophytic formation, discal hernia or spondylolisthesis, the spinal cord and its roots can be compressed and damaged. Depending on the damaged vertebra there will an alteration of one or the other spinal nerve.

6a) **The resonant box of the guitar.** It is box made of rigid walls (.....). the resonant box amplify and modulate the vibrations produced by the strike of the guitar strings.

It constitute a space filled by a fluid, the air. The fluids get resonant with the vibrations.

6b) **The dural sac within the lombo-sacral column.** In the adult the spinal cord ends at the conus medullaris at the level of L1. The dura mater continues beyond L1 forming the dural sac which lines the spinal canal and the sacrum. Within this space there are diverse structures. The filum terminale (thickness from 1.5 to 3 mm) continues the dural sac from the conus medullaris to the sacrum at the level of S2-S3.

Therefore the filum terminale occupies a space which is bounded anteriorly by the lumbar and sacral vertebral bodies, and bounded laterally and posteriorly by the vertebral arches. This space is also filled by a fluid, the cerebrospinal fluid. In neurosurgery it can be observed that the filum terminale is under tension by the TMF and its percussion reminds us of the string of a guitar (string sign).

7a)

7b) "Cauda equina". Lumbar and sacral spinal nerves fan out at the level of the dural sac.

8a)

8b) S2-S3 at the level of the sacrum. It is the anchorage point of the filum terminale on the sacrum.

9a)

9b) The sacrococcygeal ligament and the dura mater. This ligament runs from the bottom part of the dural sac and inserts into the coccyx. From this position it appears to anchor and tense the dural sac thus creating a continuum between dura mater, vertebral column and coccyx.

THE HUMAN MUSICAL PARTITION. TISSUE MEMORY

We have described the osteopathic guitar, the human monochord. We now are going to address the partition written within the tissues, the movements to execute it and the music it interprets.

Traditionally, when one speaks about memory (conscious or unconscious) it is about neuronal memory. Here we apply the term "memory" to modifications produced within the internal organisation of the tissues of an organism following an event. Some modifications are produced during embryological development (constitutional or primary) whereas others will be acquired during life (secondary).

The human tissues like other materials can contain the memory of the action they have been subjected to. Materials engineering describes two types of mechanical behaviours: some materials are elastic and get deformed without any change in their structure, and go back to their initial shape once they have freed the energy they have accumulated. Other materials are plastic which will modify their structure and will retain part or all of the energy they have received. Thus plastic materials have a memory of the forces they have been subjected to.

Smith (13), who was cited by Professor Elices, calls retaining memory materials: "funecos materials". Funes was a character of the writer Antonio Borges who had a great memory capacity. Elastic materials are "afunecos" because they cannot modify their structure and therefore cannot retain memory. Because of these particular characteristics, biological tissues and materials are a great source of inspiration for materials engineering (14).

At present researches are oriented towards intelligent organic materials able to retain memory, and able to adapt to the different conditions they are subjected to, so that they can mature and age like biological tissues. According to the Professor Elices:

"Future new materials will not be mute, blind or deaf to external stresses. New materials like human beings should be able to feel and interpret sensory information and respond accordingly. These materials of the future will be able to feel anxiety when faced with progressive aging or external painful stimuli and will try to mend the damages caused and will ask for help when overwhelmed (15).

There is great variability in the mechanical characteristics of human tissues, which are either elastic, plastic or both. For instance at the beginning of the embryological development, the neural plate, from which the brain and spinal cord are derived, has visco-elastic characteristic combined with a great plasticity and internal fluidity (16). In the adult the neural tissue of the brain and the spinal cord loses part of its adaptability whilst developing rigidity and self tension, the medullary traction force (MTF) (6).

Plastic and elastic inorganic materials immediately respond to the forces they are subjected to. Visco-elastic organic materials exhibit a time lag when absorbing forces and before being deformed by them. The quicker a force is applied the greater the resistance to deformation (17).

There is within the human tissues a constant movement due to metabolic reactions and the cellular turnover from the regeneration of proteins as well as the mobility of repair cells (macrophages, fibroblasts, osteoblasts, osteoclasts) to the defence cells (leucocytes, lymphocytes etc...). This means that many human tissues are capable of distortion however these materials are "funecos". Any action on a human tissue can produce a modification on the organisation of its structure and thus a change in its memory.

In some cases it is easy to observe changes in the tissue memory; for instance in skin scars, in adhesions in the deep fascias following surgery, in bone distortions from a healed fracture, in the cutaneous mark left by a burn, in the pain from a herpes keratitis, in the muscular contraction and inflammation following a contusion, Sudeck disease following a compression or a fracture, etc...

In order to function correctly the human monocrorde cannot "vibrate" above a specific frequency. Studies have shown that patients subjected to vibration frequencies superior to 5 Hz caused lower back pain and other types of lesions to the vertebral column (17).

In great trauma a violent vibration of the entire body is produced within a very short period of time. Since the complex brain spinal cord-filum terminale constitute an anatomical continuum associated with its own tension, the MTF, this violent vibration will be transmitted to the entire CNS (18). The neural tissue is plastic and this increase in tension can produce tissue lesions and thus create a tissue memory.

In order to hold this tissue memory energy and negative entropy is necessary (19). Entropy is second principle of thermodynamics which states that cosmic energy tends towards expansion and not concentration. Life and evolution of living being do not follow the entropy of the universe since they develop into ever more complex structures which need energy (20) (21).

THE PRIMARY INFORMATION, THE ECTODERM, THE TISSUE DIRECTOR

Particular essential information to the organism must be found in the most archaic tissues. The ectoderm was the first of the three embryological folds that appear during evolution. The other two the endoderm and the mesoderm appeared well later. During the first weeks of development of cordés there is a thickening of the ectoderm's surface which will lead to the neural plate. Subsequently this neural plate will invaginate and close which will then form the neural tube. From the neural tube originates the spinal cord and the brain.

Around this first longitudinal axis, which corresponds to the neural tube, the other part of the embryo is going to organise. Under the influence of this first axis the formation of the somites and of the notochord will take place (22).

The ectoderm is in the cordés the oldest embryological fold and the closest to the origin of life. Its physiological and structural functions are primary components of life.

Very organised tissues are very stable and their internal structures undergo very little renewal. Stability allows a better retention of the information they contain. The neural tissue contains a great deal of information and has a high level of organisation. Its metabolism and renewal rate of its structures is very low. However, tissues of mesodermic origin are very active from a metabolic standpoint and the rate of renewal of its structures is very high. The information gets stored in the neural tissue which fulfils a directive function in the body whereas tissues derived from the mesoderm have a trophic function (nutritional) (23).

Nowadays in osteopathy when we speak about structural and mechanical alteration of the human body we principally refer to alterations to tissue of mesodermic origin such as the muscular tissue, bone tissue, tendons, fascias (like the 3 meninges) etc... We must add the tissues derived from the ectoderm which anomalies can have consequences on the mechanical and functional pathologies of the human body.

ENTROPY, THE MUSIC OF THE UNIVERSE

Life is associated to degradation or dissipation gradients. Electromagnetic energy that reaches Earth from the Cosmos under light form (photons) is caught by plants through photosynthesis and is concentrated into complex organic components with a high level of energy (negative entropy).

"Life is certainly a comic process of organisation and increment" (23)

This great organised quantity of energy will subsequently consume itself during the successive steps of the trophic chain. It is an energy cascade which starts from levels of high concentration of energy (plants) to others of low concentration. Associated with the different levels of this cascade we find all the living beings of the trophic chain (herbivores and carnivores etc...).

At the same time each organism has within itself its own cascade of dissipation of energy which steps are the different tissues and organs composing it. These energetic jumps will be combined to a flux of electrons allowing tissues to produce work under the form of heat and metabolic reaction necessary to life.

"Organisms and ecosystems are material manifestations of the bridge or road which goes from the capture of photons to the final puisard of energy". (23)

All these energy cascades are linked together. At the end of all these cascades the cosmic energy will be dissipated in the form of heat and other electromagnetic radiations and will return to space where it came from in order to contribute to the entropy and expansion of the universe. Its course through life on earth will only be a slower route.

"Life is not in a hurry, the energy flux slows down when it passes through the whole chain of life. Only the cycle is not slowed down." (23)

Entropy is the universe's music on which dances the cosmic god Shiva, creator and destruction god, we all carry this music within ourselves (24).

When a living being or a tissue is disconnected from this cascade of dissipating energy, its matter becomes lifeless. The living body cannot be understood as an energetically closed system, without connections with its surroundings. When it dies the energy retained by the structure of the body serves no purpose and is given back to the Cosmos. Structure, function and energy are intimately linked.

"In living systems the structural persistence and function are inseparable so that the structure is no more, no less than a system of energy dissipation." (23)

SPONTANEOUS MOVEMENTS IN THE BODY (EMOTIONAL RESONANCE)

In physics liberation of energy occurs through radiations (like heat) or movement. Likewise it is through movement and heat that the mobilisation of the energy retained within plastic material gets organised.

The tissues of the human body produce heat and particular non conscious and spontaneous rhythmical movements. In order to understand the origin of these movements we must study the old "cordés" (fishes) our ancestors. The present constitution of man is the result of their evolution. The "cordés" are animals segmented into sclerotomes (basic unit of the spinal column). The alternate contraction of the sclerotomes produces side bending movement on each side of the body. A force is produced from back to front which in water becomes a propulsion force called undulatory movement or anguilliforme (25).

Some primitive "cordés" were hunters and their movements became oscillatory movements which when using two body fulcrums allowed them to generate rapid impulsion suitable for hunting. The movements of fishes were controlled by a very primitive nervous system. Subsequently when particular fishes adapted to airborne respiration the filum of the amphibious appeared. They moved on four limbs (tetrapods) in an oscillatory manner, using two fulcrums, one is the shoulder girdle and the other in the pelvic girdle (26). Bipedal stance appeared 3.5 millions years ago with hominids but upright gait still used two coordinated fulcrums (the shoulder girdle and the pelvic girdle). It is only 1.2 millions years ago that the hominids vertebral column evolved into an upright posture and gait (27).

In the "cordés" movements evolved in parallel with the CNS. The cerebral cortex controls involuntary movements initiated by lower centres. In evolution progress recent functions and structures sit on older ones which continue to exist even though they are not as efficient. The cerebral cortex controls the muscular contractions of involuntary movements. Simple movements such as extension, torsion, and rotation of the body originate from the diencephalon and the mesencephalon. Muscle tone is regulated by the basal ganglia (28). In animal experimentation it has been observed that lesions of the basal ganglia produce involuntary clonic type movements. In basal ganglia pathologies such as chorea the cerebral cortex loses its descending control which leads to pathological movements.

Particular models of movements are held in the unconscious mind and are at the source of the evolution hominids movements.

The limbic system is the most ancient part of our brain. It houses nuclei which regulate involuntary movements, emotions and instincts. It is not surprising that involuntary movements and emotions are intimately linked. Dance and music are utilised by particular religious practices and in psychotherapy to induced particular emotional states.

Other types of spontaneous movements have been studied, amongst them we find the primary respiratory mechanism (PMR) in osteopathy and the psycho-myokinetics movements from the motor theory of consciousness (MTC). The pioneers of the MTC have been Charles Darwin (29) and William James (30) in the XIX century. Later this theory was developed by researchers such as Emilio Mira y Lopez in the XX century (31) (32).

Dr Mira studied proprioceptive muscular activity in relation with people's personality, using a test called "psycho diagnostic myokinetic" (PMK). With the PMK the psychic diagnosis is made from the specificities of particular human movements.

"Any mental activity considered from an objective standpoint is a succession of acts which are based pre-established attitude patterns, thus each change in attitude is accompanied by a change in muscular tension and equilibrium". (31)

This means that in order to think our body takes a pre-established attitude.

We achieve our position in space by activating particular muscle groups and by inhibiting others. In the same way we cannot achieve a particular movement without being mentally predisposed to it. Small involuntary movements in relation to our thoughts and emotional state occur in an unconscious fashion. These movements can be highlighted by high speed kinematic techniques, by the study of the PMK trace and by graphologist tests (33). When writing we actually draw movement. The trained palpation of the osteopath can also detect these movements. Depending on the emotional state of the patient these movements have a rhythm, amplitude and a harmony specific to each individual and to each situation.

Movements of the human body that we have described separately are coordinated and occur in unison.

We therefore observe that movement is more than the activation of muscle groups in order to achieve a displacement in space. Movement is intimately related to consciousness.

OSTEOPATHIC TREATMENT AND THE ART OF PLAYING THE GUITAR

During treatment the osteopath occasionally holds himself in postures that remind us of guitar playing postures.

The osteopath visualises and works on the tensions of the cranio-sacral axis, by increasing or decreasing these tensions as if it was a string. He "vibrates" this string by accompanying with his hands the movements that occur in the body, looking for a kinematic harmony and correcting mechanical restrictions. By his hand contact he allows the gradient of dissipation of energy to occur in the tissues. Heat and movement will be the mediums of the circulation of energy. The internal entropy of the body and the connection with the energy cascade will be enhanced allowing the restoration of the self healing mechanisms the philosophy of Still refers to (34).

Still also highlighted the interaction existing between the structure and the function of an organ (Structure governs function) (34). This means that by acting on a structure (the neural axis) we also act on its function (the neurophysiological activity).

Childhood is a period of great interest for the osteopath. The spinal column of the newborn has a single curve and the conus medullaris is at the level of L3. The difference of length between the spinal cord and the spinal column increases with increasing age and leads to the relative migration of the conus medullaris from L3 to L1 and to the occurrence of the 3 spinal curves. Osteopathy can facilitate a harmonious migration by avoiding blockages from external tension resulting into an increase in MTF.

Osteopathic treatments respect and accompany the body spontaneous movements. They are a dialogue with the body kinematic and emotional melody. Within a healthy body these movements are soft, rhythmical and harmonious.

"When the body is healthy and full of vitality every organ emits vibrations that are in harmony with mental, emotional or spiritual manifestation." (35)

These movements are spontaneous within the body and are accompanied by the osteopath. Since these movements remain within physiological articular ranges and they do not generate any discomfort to the patient. The body protects itself against harmful movements through pain and muscular contraction.

Through our hands movements are perceived differently whether the hands stay immobile or follow the movement. If movement is being followed freely, one can feel their amplitude, rhythm and vital force. If movement is being opposed by a static palpation, one can observe the response and the struggle to the resistance being created.

This means that by accompanying movements we observed the expression of their spontaneity and freedom.

Our movements are linked to our emotions. In particular emotional states we find a repetition of specific movement patterns. Different types of movements can be observed such as undulatory, oscillatory, slow and long, rapid and short, broken up, etc... This is obvious in the two phases of manic depressive illnesses.

"Every idea is accompanied by a movement and by following this movement we can deduce the idea from it."
Carpenter (31)

Music composers writes specific melodies in order to induce particular emotional states in the listener, such as fear, sadness, joy, uncertainty, etc.... In order to achieve these special effects they use musical intervals which the distance between two notes.

Silence in the middle of a melody produces the sensation of an unresolved situation. In osteopathic treatments we also look for these silences called "still points", they precede the liberation of numerous tissue blockages.

Undulatory movements are a constant in the Universe, in man's life and in the music of the guitar player. We receive the energy that life gives us through solar light (electromagnetic waves). Our body expresses itself through undulatory movements which reside deep in our consciousness furthermore we express our emotions through vibratory waves which like the guitar strings, are transmitted through air, like a fluid.

Observing a guitar player creating his music help us understand old osteopaths like Still. They understood the human body from all different angles and did not consider disease simply as a somatic dysfunction.

The osteopath with his patient is like the guitar player with his instrument, the actions of his hands are much more than a collection of movements or manipulation well thoughts and well executed.

"Music is the art of combining melody, rhythm and harmony."

Harmony is the art combine, balance and arrange things....." (36)

"The guitar is one of the most complete instrument of the orchestra since it is possible to use it in relation to harmony, melody and rhythm". (8)

REFERENCES:

Figure n°1 The divine monocorde

Diagram of Robert Fludd XVII century (37).

Figure n°2 – The guitar and the human monocorde

Author : A. Ruiz de Azua & J. Elizalde

The numbered pictures are explained in the text. For more clarity images 7a and 7b were removed. Pictures 5 and 6 refer to the cauda equina and its resemblance to the rays of a fan.

Figure n°3 – Similarities between the postures of the guitar player and of the osteopath

Author : A. Ruiz de Azua & J. Elizalde

Figure n°4 – MRI of the dorso-lumbar junction area

Author : A. Ruiz de Azua

This is an MRI sagittal section of the dorso-lumbar junction area, the patient is 57 years old without known pathologies of the vertebral column. The complex spinal cord, filum terminale and cauda equina reside within the spinal canal and follows the straightest path between the extremities of the curves of the spinal column. The spinal cord has a tension following the cranio-sacral axis which explains its off-centre path within the spinal canal and the fact that it does not follow the vertebral curves. The dura mater exhibits less tension in this cranio-sacral axis which allows it to more precisely follow the vertebral curves.

Figure n°5 – MRI lumbo-sacral junction area

Author : A. Ruiz de Azua

This is an MRI sagittal section of the lumbo-sacral junction area of a 44 years old patient, a hernia at the level of L1/2 can be observed and protrusions at the level of L3/4 4/5

Figure n°6 – diagram an MRI of the lumbo-sacral junction area

Author : A. Ruiz de Azua & J. Elizalde

It is recommended to consult the photograph of the dissection part published in the article “the medullary traction force” (6). In the living subject the cerebrospinal fluid is positively pressurised and is surrounded by the subdural space which is in negatively pressurised. The dural sac like a swollen balloon adapts to the structures containing it.

1. L1
2. L1/2 herniation protruding in the spinal canal
3. The dura mater superposed to posterior longitudinal ligament and separated by the L1/2 hernia from the posterior part of the vertebral body
4. The dura mater in the posterior part of the spinal canal
5. Spinal cord
6. Under the medullary cone the filum terminale and cauda equina can be observed
7. Elements of the cauda equina under ray form (the human monocorde fan)