

Restoration of Lost Sensory Motor Control following Stroke with Vasa concept

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Restoration as against the contemporary palliative approach in stroke rehabilitation

- Today, I wish to introduce how to restore lost sensory motor control following stroke; to this august audience of this most eminent centre in the world for stroke rehabilitation where, I was a student once upon a time.
- I feel nostalgic being here and take pride in saying that journey of Vasa Concept for restoration of lost sensory-motor control following stroke began in my mind right from here in this centre.













Current belief

- Motor disorders are believed to be directly related to cerebral lesion in any neurological condition.
- Neuro-rehabilitation is considered to be palliative.
- Plasticity is considered very important in rehabilitation and is largely understood to be positive.
- Recovery in chronic state is understood to be from reorganization of the brain.

Contemporary Focus is on:

1. Making the patient independent in ADL.
2. Treating Negative and positive symptoms of muscles with several old techniques without evidence and some new techniques with evidence.

I believe that muscle is simply a victim of CNS lesion therefore focus must shift from the symptoms to the Root cause behind the symptom.

Balance:

Normally
balance is an
automatic
sub-conscious
affair.



Balance II:

Encouraging sensory reweighting using cortical conscious sense like vision, touch and vestibular sensation for balance, to compromise for reduced proprioception makes 'Normally - abnormal to become Normal.' from adaptation with passage of time for stroke subject.



Balance training in Vasa Concept

Despite “**complete loss of sensibility**”, balance can be restored completely by exploiting following;

- Freely available **gravity**. *[No money to be spent]*.
- **Brain** of the stroke subject as the most powerful tool compared to any man made machine. *[No extra costs]*
- Paretic weak spastic **muscles**. *[To be used and not abused]*
- **Peripheral nervous system [PNS]**, *is normal in all stroke subjects*.

Where is the catch?

- Catch is that the selforganized CNS is much more powerful than any of the externally induced most modern therapeutic balance training.

Unless

Therapeutics begin to speak the same language of the selforganized brain and i.e. to prioritize safety of COM by bringing the change from within and not from outside.

Muscle simply is a victim of CNS lesion.

I feel we must outgrow our desire to treat negative and positive symptoms as *muscle, simply is a victim of CNS lesion* and therapeutics must no longer victimize the muscle further, by trying to strengthen it from outside with progressive resistance exercises [PRE] or inhibiting spasticity with inhibitory exercises.

We Must Question ourselves.

- Why negative symptom like weakness and flaccidity changes into positive symptom, “the spasticity”?
- What is the possible role of spasticity in the realm of optimally acting brain?
- Why spastic muscle offers high resistance to yield but continues to remain weak?
- What could be the possible role of passive tissue contracture following stroke for a dynamic self organizing brain that always works optimally.
- Why would brain waste its energy in developing passive tissue contracture and spasticity both?
- What could possibly be the motive of the brain, that normally works on OPTIMALITY (Emmanuel Todorov) principle, to develop contracture and spasticity?

“U” turn

To answer these questions, we need to change our thinking.

1. We need to take a full “U” turn from treating symptoms to identify the real culprit besides lesion behind the development of chain of symptoms in the muscle that evolve with passage of time following stroke .
2. We need to move away from palliative treatment in rehabilitation which is anyway refractory.

CNS priority

- Following stroke, one side of the MSS becomes flail and weak and is unable to combat the force of gravity.
- Selforganizing CNS instantly shifts control to non paretic MSS with instant plasticity to control and defend COM (centre of mass) as its priority.

Selforganized brain is mightier than any therapeutic technique in the world unless selforganized brain is approached with the same language that it speaks. That is to prioritize safety of COM.

Spasticity (I)

- As a clinician, we must try to know limitations of theoretical definition of spasticity based on laboratory experience when the spastic subject is lying passive and researcher is actively attempting to move the limbs under testing.
- We need to consider patient's experiences of spasticity in their daily life and experiences of therapist about spasticity in clinical practice.
- We need to think if, we can prevent spasticity from surfacing at all!
- Once spasticity sets in, can we get rid of it?

Spasticity (II)

- If we did, it will save huge amount of time, energy and money of the patient, family and above all, use of state funds coming from tax payer's pockets for better cause.
- As a clinician in motor control science, I feel the need of reviewing birth of spasticity with clinician's view point is of critical importance.
- We need to consider possible reasons other than the lesion, why spasticity surfaces at all in patients during postural and supra postural tasks.

My perception about spasticity:

- I think that the term spasticity is dedicated to stretch reflex in unloaded condition (*subject is lying supine when researcher is testing the spastic limb*) during clinical examination.
- The term Spasticity does not “deserve” to be used in functional conditions such as during locomotion to define continuous extended muscle activity.
- I feel that spastic contraction in muscle is usually a **prolonged continuous activity** (not a phasic activity) as a result of **proactive anticipatory central command** (not as a **reflex reaction to muscle stretching**).

Clinically applied definition of spasticity in Vasa Concept.

Prolonged activity of “spastic” muscles is an endeavor of self organized stroke CNS to restrict the increased degrees of freedom of paretic flail segments with continuous proactive anticipatory contraction in chain of muscles to restrict the boundaries of COM movement in different Cartesian coordinates in self defense for; safety of COM is always a priority for all living self organizing biological system.

Unending struggle of the therapists.

- Inability to weight bear and weight shift on paretic side during walking poses huge threat to the safety of COM with different consequences in different subjects with different challenges for therapists.
- Some may not want to take a risk to walk at all and prefer to be in wheelchair

And

- Those who can walk.....

Unending struggle of the therapists [II]

Those who can walk, their CNS tries to restrict COM from going laterally and forwards in anterior direction of Cartesian coordinates on paretic side.

With following;

1. **Contracture**
2. **Spasticity**
3. **Rigidity**
4. **Freezing of COM.** (*Freezing of stroke subject from fear of falling becomes very challenging for therapists to help gait and other higher level mobility and balance tasks though there is good physiological recovery*).

HEAD ARM TRUNK [HAT]

- Gravity bends the trunk passively at the hip, thereby helping the paretic LL to remain unloaded from head arm trunk mass thereby preventing the LL from collapsing with weight of HAT, thereby providing safety to the COM.



Interactive Forces



Paretic weak MSS being part of the total *link* gets dragged with non paretic MSS that is used for control of COM during postural and supra postural tasks. Paretic MSS faces **interactive forces** generated from movements of non paretic segments being mechanically connected at the central axis.

Binding and towing of paretic MSS (I)

Binding and towing of paretic MSS is an endeavor of selforganizing stroke CNS on optimality principle.

Binding and towing of paretic MSS (II)

Contracture and contraction in the specially arranged anatomical structures of spine and those which span over from spine onto limbs sets sequence of events with snow ball effect in presence of gravity that leads to mechanical **binding and towing of paretic MSS.**

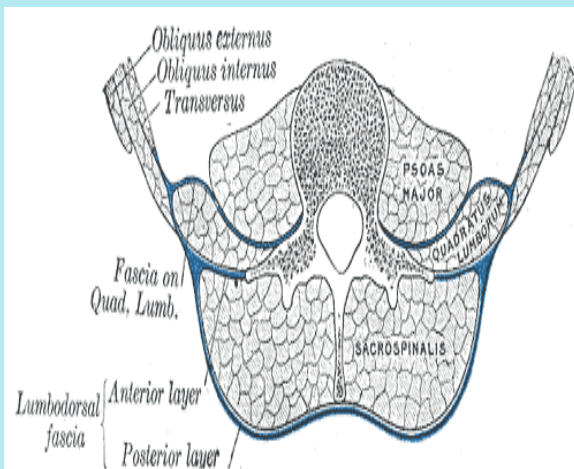
Thoracolumbar fascia.



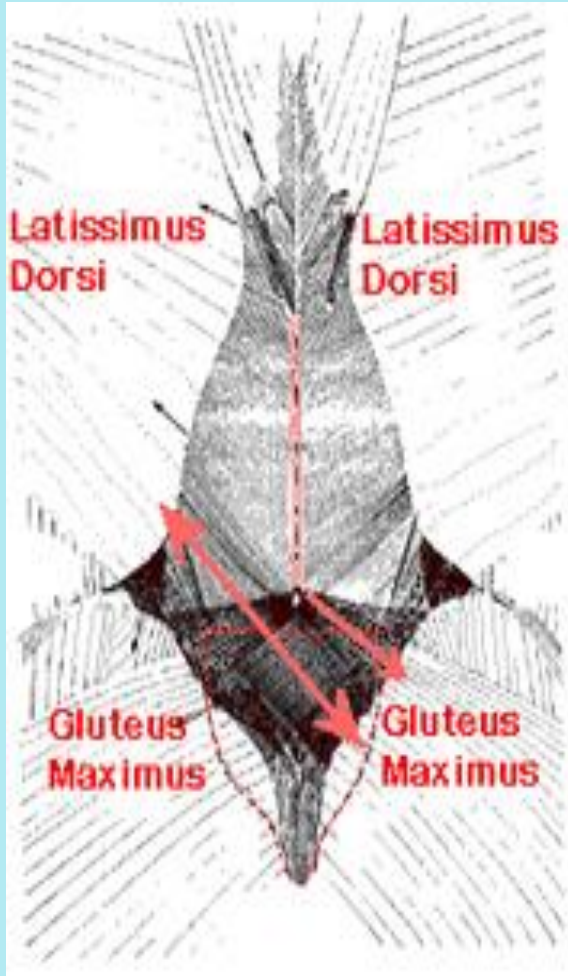
- Basic fabric of the spine that integrates both sides of MSS.

And

- It houses large number of muscles dorsally and ventrally directly and indirectly.



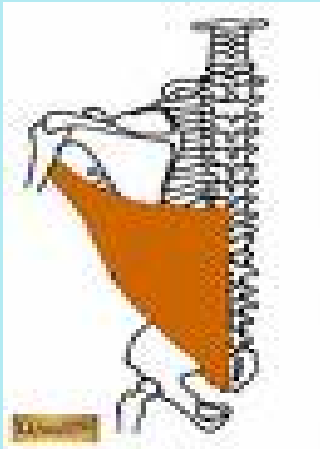
Paretic lattissimus in continuity with non paretic gluteus maximus



Allows swing of the arms during gait when normal.

Contracture and spasticity in Lattissimus on paretic side pulls the arm in adduction and prevents swing of the arm and any change in direction of the UL away from central axis.

Lattissimus and Pectoralis Major

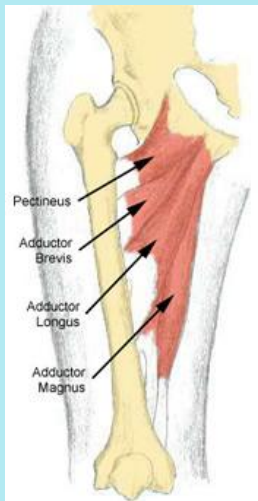
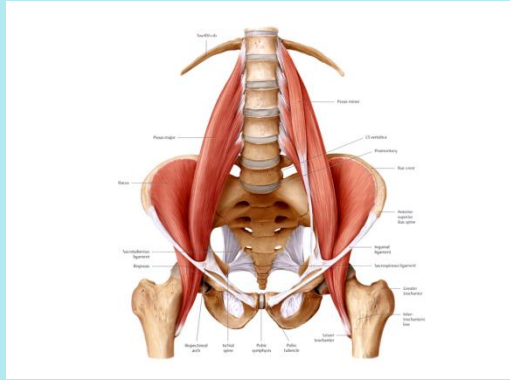


contracture in Lattissimus binds arm, scapula and pelvis together and turns it into *a log* like structure that helps restrict movement of COM.



Contracture in pectoral muscle helps *to bind* the arm to the trunk.

Psoas and hip adductor



- Contracture in Psoas which is attached to the spine and onto the femur helps bind the hip to the trunk giving passive stability to the passively bent hip in flexion from the bent torso because of the gravity.
- Contracture and contraction in hip adductors pull the hip towards the central axis and bring the LL mass to be within the safety zone of BOS provided by non paretic LL.

FLEXION SYNERGY AND BICEPS



Biceps over activity makes the arm lever to shorten and bring the UL closer to the central axis, helping the COM not to run out of the safety zone, thereby prioritizing safety of COM.

FUNCTIONAL TOWING of PARETIC MSS (I)

Binding the paretic MSS with non paretic MSS at several levels as just described with contracture helps the non paretic side to functionally tow the paretic side optimally.

FUNCTIONAL TOWING of PARETIC MSS (II)

Anticipatory continuous spastic contraction couples many segments together in synergy called flexion / extension synergy. This helps:

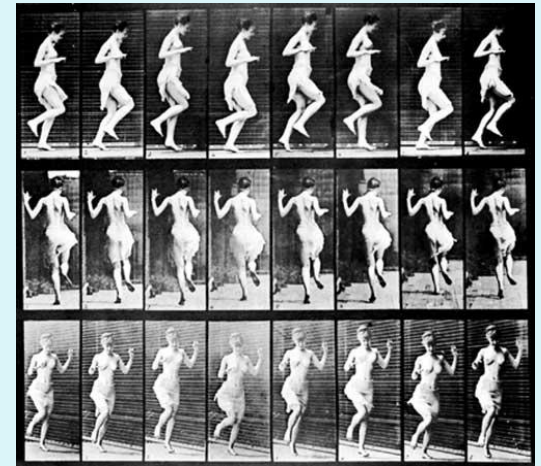
1. To sustain the segmental mass optimally while towing.
2. Does not allow segments to change direction except one direction and that is towards the central axis thereby providing safety to the COM
3. Spastic contraction acts as a BRAKE on the COM movement to restrict it to remain within the support surface.

Use dependent plasticity and adaptability.

- Adaptability and use dependent plastic changes can be negative against all efforts of therapists.
- Structural changes from use dependent plasticity and spatiotemporal efficiency combined makes it very difficult for the patient **“not to, not use”** good non paretic limb compared to learned non use and forced use of paretic limb.
- Adaptability and use dependent plastic changes makes it highly difficult for the therapists to make the patient learn to weight bear on paretic lower limb and force the use of paretic upper limb repetitively by constraining the good upper limb

Physiological inter limb coupling

- Activities like stair climbing, walking, and sit to get up from chair etc results in physiological inter limb coupling.
- Reduced loading of LL during postural and supra postural tasks especially when non paretic limb controls and regulates the COM, anticipatory activity gets triggered in chain of paretic muscles to prioritize safety of COM.
- In addition to anticipatory drive, physiological spinal inter limb coupling from spino-spinal reorganization and stretch of the paretic segments from inertial load with gravity acting as a stimulus makes the paretic UL to go in flexion posture labelled to be abnormal pathological synergic grouping with Biceps over activity, **which in reality is normal under the circumstances as long as paretic LL remains unloaded.**



First Vicious circle [I]



Naturally healing and selforganizing stroke CNS gets trapped into a vicious circle let us see how:

- Selforganizing CNS depends on non paretic MSS to control and defend COM (centre of mass) as its priority and endorses *not to depend* on the paretic MSS for equilibrium. For; safety being a priority for all living selforganizing biological systems.

First Vicious circle [II]

Paretic MSS with poor contact with the ground from inability to bear weight and inability to control COM begins to depend on the non paretic good side for external **gravicentric reference** being connected with it at the central axis and reinforces the **egocentric reference with central axis** to be able to follow the good MSS optimally and get towed by good MSS mechanically efficiently.



Video Link: [Carol on Stairs](#)

First Vicious circle [III - A]

Peripheral nervous system (PNS) with its afferent inflow sends the exact peripheral information about ongoing state of paretic MSS and non paretic MSS. **This is the corner stone of the vicious circle** among reorganized CNS and paretic MSS.



Video Link: [David on two elbows](#)

First Vicious circle [III - B]

Peripheral nervous system (PNS) with its afferent inflow sends the exact peripheral information about ongoing state of paretic MSS and non paretic MSS. **This is the corner stone of the vicious circle** among reorganized CNS and paretic MSS .



Video Link: [Robert Karl – Foot Turning](#)

Second Vicious Circle

Spasticity becomes a major factor for causing further instability, further disequilibrium (and vicious circle).

Reduced proprioception from reduced loading of the limb also causes added disequilibrium.

Third Vicious Circle

- With passage of time, morphological changes begin to develop with contracture, loss of sarcomere, loss of viscosity in spastic weak paretic muscles so that contracted spastic muscle does not yield easily and can restrict the movement of COM thereby prioritize safety of COM.
- Continuous dialogue between CNS, MSS and the external environment (with variant and invariant gravity as forces) makes “the controller” the CNS turn to get controlled by MSS “the controlled” with simultaneously ongoing sensory inflow from PNS to maintain safety as a priority
- Adaptability of CNS and use dependent plastic changes in distant areas of the brain become negative influence for any chance for selforganized stroke CNS to get out of the vicious circle.

Snow Ball (Negative) Effects

Amplification property and selforganizing characteristics of the brain can multiply initial few constraints many fold and give rise to snow ball effect making “Normally abnormal, as Normal” with synergic grouping, associated reactions, spasticity, Paraesthesia, neglect, fear psychosis, pusher syndrome etc with slightest disturbance to self organizing non linear system.

Snow Ball (Positive) Effects

Vasa Concept exploits this amplification property of the CNS to amplify the restoration of speech, restoring cognitive and perceptual ability, and selective movement by prioritizing the safety of COM with paretic side forced to control and restore COM automatically subconsciously without external interference simply by re-re-organizing selforganized stroke CNS. (postural centers are exploited fully as they are highly interlinked to all cortical and sub-cortical centers.)

What is Vasa Concept?

Vasa Concept is:

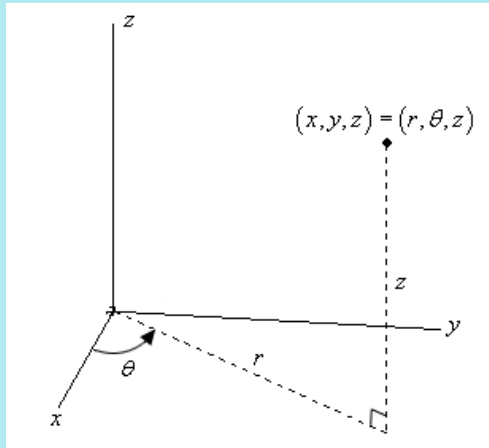
To prevent, following provisional arrangement made by self organizing stroke CNS from becoming permanent;

- To outsource motor power exclusively from non paretic MSS to prioritize safety of COM.
- To outsource sensations with sensory reweighting from visual vestibular and tactile sensation to compensate for the proprioceptive loss from reduced loading of LL to prioritize safety of COM

What is Vasa Concept? [II]

- To prevent the paretic side MSS from turning a follower of the non paretic good side that leads uninterruptedly.
- To prevent the need for passive tissue contracture and spasticity and abnormal synergic grouping triggered by selforganizing CNS to reduce increased degrees of freedom from paresis by preparing the niche for voluntary control in paretic segments with restoration of automatic control on COM in standing, sitting and walking.

What is Vasa Concept? (III)



To expand the boundaries of COM movement in all the Cartesian coordinates on paretic side of the central axis.

To promote exchange of dominance between two sides of the MSS so that both sides are able to lead and to follow depending on the need of the moment.

What is Vasa Concept? [III]

To make paretic side MSS capable to control and regulate most regulated variable the global COM spatio temporally effectively automatically without external command or third party's influence

What is Vasa Concept? [IV]

- To re-re-organize self organized stroke CNS.
- To monitor dialogue between stroke CNS, MSS, PNS, and external variant and invariant forces in specially designed postures so that paretic MSS do not turn a controller under the behest of invariant force gravity and start controlling stroke CNS as against the role of CNS as a “controller” and MSS as what is “controlled” against the force of gravity when normal before stroke

How to help the selforganized CNS to re-re-organize? [I]

To re-re-organize the selforganized brain one must first "undo" what the selforganized brain has done in terms of *creating mental divide between two sides of MSS* by endorsing on non paretic side to control and restore COM during all postural and supra postural tasks and to avoid use of paretic limbs to control COM for priority reasons and prepare it to act as a BRAKE on COM and thereby defend COM rather than control it

Help the selforganized CNS to re-re-organize by.....

Therapeutically channalizing the dialogue between brain, body, and the external environment,

With following;

- Reconfigure entire linked MSS wherein non paretic limbs are part of **one whole posture** to reduce mental divide between the two MSS for; **“one whole is bigger than sum total of its individual parts”**.
- Spastic / flaccid all segments are cornered and targeted to mechanically passively support posture and control COM with some external assistance if necessary.
- **Video:** [Carmelo hoping on one leg](#)

How to help the selforganized CNS to re-re-organize? [II]

Torso with its huge inertial mass is exploited in a specially designed postures like



Buddha Posture



Namaaz Posture



Side Sitting on Butt

How to help the selforganized CNS to re-re-organize? [II]

- to tap bilateral innervation of torso to **re-re-organize** cerebello-cerebellar connectivity and spino-spinal activity to influence final common path of ventral neurons with movement of non paretic limb to trigger controlled disequilibrium to **unleash avalanche of anticipatory proactive activity in chain of postural muscles** from within thereby break the cycle of monotonous afferent inflow from paretic side and channalize sensory motor output from within as desired.
- **Video:** [Carole \(Buddha Posture\)](#)
- **Video:** [Bharat Bhai](#)
- **Video:** [Carmelo \(Rollover\)](#)
- **Video:** [Bharat – Manoj \(Good leg moving forward backward\)](#)

Unleashing Avalanche of Postural Motor Neuronal Activity

Weakness can be combated and muscle can be strengthened without externally induced PRE with gym instruments by unleashing avalanche of **intrinsic activity in eagerly awaiting motor neuronal pool which is longing to get connected and are available in abundance at several levels of neuraxis** to control posture and *restore* COM using paretic muscles when given an opportunity.

One can make paretic muscles not only capable to control and restore COM but can *make a small lesion in the brain completely irrelevant* and can restore speech, cognitive control and lost sensory motor control sub-cortically automatically as a byproduct by prioritizing safety of COM with paretic MSS.

CONCLUSION.

- Vasa Concept is to **re-re organize** the selforganized stroke CNS to put an end on the vicious circle among CNS, MSS, and COM that triggers most unwanted and undesirable negative postural reaction that includes spasticity, rigidity, co-contraction by exploiting MSS as a window to the brain and also to influence the COM in presence of gravity to generate GRF to channalize the dialogue between stroke CNS, MSS, and PNS for desirable results **that makes the lesion irrelevant.**