Management Approaches for Spasticity in Children with Cerebral Palsy:

A Critical Analysis

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Can We Identify the **Diagnostic Differences** in These Two Children?
POLIO - disappeared as major cause disability

and so,

Entire resources (manpower and finances) directed for other clients with neurophysiologic disorders i.e.

Cerebral Palsy etc.

This led to:-

Physicians and therapists started treating Cerebral Palsy from an ORTHOPEDISTS PERSPECTIVE, with surgery, bracing and muscle re-education.
So, the Question arises are;

- Can the **treatment concept will be same** when etiologies has the differences?

| Poliomyelitis where Anterior Horn Cells are the site of the lesions | Cerebral Palsy - Where pathologies lies in the Central Nervous System |
Abnormal Posturing in 2 Different Neonates of same age

High Risk Neonate
20 Days Old
Abnormal Posturing

Normal Child
24 days Old
Postural symmetry

Are they Spastic?
What You Think of These Neonates?

Do they Develop the Muscle Tightness as a result of **SPASTICITY** in their **neonatal Age ONLY**?
To Understand the effect of Spasticity on Skeletal Muscles of UL, LL and Trunk?
We must understand about the Transmission of Musculoskeletal Forces in active Typically developing or a child with CEREBRAL PALSY.
Forces, generated during **CONTRACTION OR PASSIVE ELONGATION** are predominantly transmitted

a. to bones via **tendons and aponeuroses (MYOTENDINOUS PATHWAY)** and

b. through surrounding **CONNECTIVE TISSUES (MYOFASCIAL PATHWAY)**.
SO,

What Causes the **Cascade of Changes in Muscles after Neurological Insult**?
Cascade of Changes in Muscles after Neurological Insult

Altered Neurologic Function
  → Increased Tone
  ↓ Elasticity = ↓ Ability to Stretch to Full Range
  ↓ Altered Muscle Growth (↓ Length)
  → Contracture

Effects on Growing Bone

Application of Abnormal Force to Bone
  A child’s bone is:
  “biologically” plastic
  will change growth
  “mechanically” plastic
  will change shape

Altered Growth
  Torsion
  Angulation
  Length
  “Lever arm dysfunction”

Changes in Muscle Forces and Joint Integrity

These changes lead to Muscle Fiber Stiffness in Children with Cerebral Palsy in which, the role of TITIN (Elastic component) Protein is very important.
Any change in muscle fiber diameter facilitates change in the number of TITIN Filaments that is \textit{ARRANGED IN PARALLEL} Orientation causes proportional change in \textit{ABSOLUTE PASSIVE STIFFNESS} of the muscle fiber.

Therefore, change in \textit{MUSCLE FIBER TYPE} along with change in \textit{MUSCLE FIBER SIZE} in spastic muscles; influences \textit{PASSIVE MUSCLE STIFFNESS}.

Magid & Law, 1985; Linke \textit{et al}. 1996
Do you know about the Cellular Changes happens in Spastic Muscles?
Cross Section of Muscle Fascicle of FCU

Pathological Signs - Presence of Central Nuclei
Thickness of Perimysium in Controls and CP
Skeletal Muscles: Changes in Cerebral Palsy Children

Fewer muscle fibers,

Shorter fiber length, and

Longer tendon.

This causes:

Weak muscles due to reduced cross-sectional areas &

Decreased excursion, resulting in reduced ROM because of

short fiber lengths.
Pathophysiology of Movement Disorder in Cerebral Palsy: Effect on Muscles Functioning
Release of Primitive and automatic movements

a. +ve signs of CNS Dysfunction:

* Abnormal Reflexive tone states and abnormal movements_ not seen in intact CNS functioning.

b. -ve signs of CNS Damage:

* Result of direct damage to motor control areas of CNS_ causes loss of motor control functions.
b. -ve signs of CNS Damage: - contd.

* Loss of co-contraction,

* Loss of reciprocal inhibition,

* Delayed termination of motor unit activity,

* Prolonged sustaining of firing of muscle activity (loss of ability to terminate this activity),

* Restricted ROM.

Note: many researchers find a more direct correlation of these –ve signs of CNS dysfunction to the child’s skill level then +ve sign to the child’s skill level.
If, Typically Developing children- sarcomeres are stretched, maximal force production will increase, whereas Opposite happens in CP- sarcomeres. Muscles represented include Gracilis, Semitendinosus, Soleus, and FCU.

Does **Musculoskeletal Operations** in Children with CP helps to Gain Motor Control and Functional Changes successfully?
3D ultrasound images and segmentation of muscle volume of a child with Spastic Paresis: Pre and 12 MONTHS POST- MEDIAL HAMSTRING (ST) LENGTHENING
Findings of 3D ultrasound images Post 12 MONTHS of MEDIAL HAMSTRING (ST) LENGTHENING in Spastic CP

• After surgery, this child showed

a. Reduction of muscle volume by 26%,

b. Decreased muscle belly length by 32% and

c. Increase in tendon length by 62%.

Impact on Muscles in CP Children following Musculoskeletal Surgeries

Reduction in Number of Sarcomeres

Muscles Wasting

Altered Sequences and Abnormal Pattern of Muscles Firing during Functional Activities

Impacting the Functional Status of a Growing Child with CP
Hence, the Innovative therapeutic strategies are the KEY for the success in SPASTIC MUSCLES OF CHILDREN WITH CP.
Focus for the Therapeutic Strategies in Children with Spasticity

1. Trunk: ROM and Extension/Flexion Rotation Control

2. Eccentric Muscles Facilitation
Importance of Trunk Control

• Trunk represents over half of the body mass and has major role in body’s overall postural control

• In-spite of this, clinical assessment and research (compared to limb movements) on trunk is largely been ignored.

Many clinical tests, that are appropriate for assessing the extremities i.e. ROM, Proprioceptive testing are inappropriate when applied to trunk.
Importance of Trunk Control

NEGLECT OF TRUNK

may result in misinterpretation of problems seen in UE or LE;

because trunk serves as the center of control for distal movements.
Trunk Control - Anatomical and Functional Significance

- All normal Functional Activities - Depends on Trunk Control as basis of Movement.

- UE - Attached to trunk by Sternoclavicular Joint, by muscles and other Soft Tissues.

- LE - Attached to trunk by Hip and Pelvic Bones

Posture of Trunk and Pelvic - Influences position of scapula and Clavicle, which in turn has direct muscular and biomechanical effects on all movements of UE.
Trunk Control- Relation with Neck Holding

- Similarly, Inability to hold the head in midline- is a major concern in Neurological cases.

- Inability to hold the neck in Midline- May result in retention of STARTLE RESPONSE LONGER.

- Insufficient trunk and Neck control- affects the body’s ability to maintain it upright against the gravity- causing child to use UE to PROP, when placed in sitting – making child to get stuck, as they are unable to move in or out of that position due to fear of fall.
Trunk Control - Normal control in any parts – demands the ability to dissociate different parts of the body.

- UT - From T⁷ and above

- LT - From T⁸ and down

e.g. While UT is rotating, LT and Pelvis may be laterally Flexing. The point of dynamic stability for this dissociation is T⁷-T⁸
Trunk Control - An individual must experience movement and control at higher developmental levels against gravity prior to achieving full balance control at lower developmental level.

• When child come up against the gravity, he doesn’t develop balance reactions at one level, unless he is put in situations in which balance reactions at higher levels against gravity is required.

• At each level, he needs to be working on something higher in balance; to gain full balance control at lower level against gravity.
Trunk Control- Midline control is not COMPLETE without some ability to rotate

• When the infant is gaining midline control in the entire trunk, he would have already started working on his control in lateral and rotational movements.

E.G. While sitting and using hands in midline at 7 months, he is already using components gained earlier when pivoting in prone with lateral flexion and rolling with rotation.
Trunk Control- Good postural control of trunk includes need for normal range, dynamic stability and points of control

<table>
<thead>
<tr>
<th>Normal Ranges of Trunk Motion</th>
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<tbody>
<tr>
<td>Flexion</td>
</tr>
<tr>
<td>Cervical</td>
</tr>
<tr>
<td>Thoracic</td>
</tr>
<tr>
<td>Lumbar</td>
</tr>
<tr>
<td>Entire Spine</td>
</tr>
</tbody>
</table>

Source: Kapandji I: The Physiology of Joints- The trunk and the Vertebral Column. New York, Churchill Livingstone, 1974
Trunk Control - Good postural control of trunk includes need for normal range, dynamic stability and points of control

- **Dynamic Stability**

e.g. When a child is sitting and reaching forward for an object with his Right hand, the movement initiates at the hand and the head and UT. As he reaches forward, the COG, shifts and the trunk needs to counterbalance the movement to prevent falling. The reaching on the RIGHT is controlled, therefore, by lateral flexion and extension on the LEFT side.

If this doesn’t happen, the child would fall in the direction towards which he reached (RIGHT side).

Hence, free function, in UE and LE depends on dynamic stability within the trunk.
Trunk Control- Good postural control of trunk includes need for normal range, dynamic stability and points of control

- Points of Control/ Movement Initiation

Trunk flexion happens when we move down and forward. Following the initial flexion movement, the trunk extensors fire in order to grade the movement in flexion.

**Most UE based functional tasks, involve initiation of the movement in hand, often with UT initiating the weight shift.**

**For the functional tasks involving gross motor skills, the initiation of weight shift occurs in the LT and Pelvis.**
Areas to be Looked for in Spine Examination

- Lateral curvature of spine
- Truncal asymmetry
- Uneven shoulders
- Prominent scapula – uneven height
- Rib-hump
- Uneven hips
Pediatric Spine: Examination Technique

Examination Position:

1. Sitting

2. Standing
Pediatric Spine: Examination Technique in Sitting

1. On Bench or
2. On Bolster
Trunk Assessment in Children for PT

Observation and Assessment of;

• Highest functional level without assistance and with assistance.

• Overall tone distribution, UT Vs LT.

• Abnormal Patterns of Movement (Lack of Dissociation).

• Information what Therapist feel under hand

• Alignment, ROM and Asymmetries

• Balance Reactions.

• Sensation and Perception.
**Trunk Assessment in Children for PT**

**Analysis of;**

- Asymmetry of Function
- Immobility
- Consistent abnormal pattern of Movement
- Influence of Tone on above factors.
Summary of:

• How the above findings related to the quality of function

• Treatment plan to achieve goal related to function.
Consistent abnormal pattern of Movement

• Beginning with Initiation of Weight shifts- Trunk

• Specific Movement in Trunk, e.g. Lateral, rotation and Where?
Lets Look at some of Therapeutic Strategies to develop Eccentric Control in Trunk, UL and LL muscles for the inhibition of Spasticity and development of active Control in Children with CP
Spine Rotation on Bolster:
Correcting the Flexion posture of spine and as extension develops slowly bring rotation in spine and then using forward righting develop active control in spine.
Spastic Triplegic CP:
Extension Control with
Hip Adductor and Flexor
Inhibition while using
Forward Righting on
Therapy Ball,
Spastic Triplegic CP:
Extension Rotation
with Eccentric
activation of LL
muscles
Spastic Triplegic CP:

Extension Rotation Control

with Eccentric Activation of LL muscles while child is actively using UL for Righting bringing Symmetry in UL.
Change in Functional alignment in Spastic Triplegic CP using Bilateral Elbow Crutches for Independent Standing.
Spastic Tripalegic CP:
Using Both Hands for Opening the Wrapper while seated.
Self Initiated Eccentric Activation of Iliopsoas, Hanstrings and Plantar Flexors with Trunk Control and UL Righting on Physioroll.
Trunk Control on Ball with Inhibition of Extension Thrust in LL
Trunk Control with Inhibition of Knee Flexion Thrust
Hip Extension Facilitation
Effect of Corrective Anti-spastic Therapeutic Strategy on Body Posture in Spastic Quadriplegic CP.
Thank You
Any Questions......


