POSTURAL CONTROL
AS THE BASIC TREATMENT
OF THE NEUROLOGICAL PATIENT

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INTRODUCTION

Due to the injury, the hemiplegic patient loses the use of a body part and consequently the body schema changes. It changes because a body part is used more, because of a loss of sensitive information from the affected side and the decrease in APAs (anticipatory postural adjustments) activities from the less affected side. Because of the loss of the ipsilateral way of the reticulo-spinal system, the loss of the stability on the less affected side, the loss of voluntary movements from the affected side, the voluntary movements of the less affected side are made by the trunk, which is weak also in the less affected side. Moreover, in the less affected side there aren’t any normal movements and therefore the patient should be placed in a framework of tetraparesis.

The sensory information plays a fundamental role for postural control. Horak says that postural control is a complex motor skill that results from the interaction of multiple sensory-motor processes. Sensory information must be incorporated in the body schema, which is responsible for postural orientation. The postural orientation is the basis of postural stability.

The goal of treatment is to optimize the function by improving postural control and selective movement through facilitation.

It’s important to align the components in joint and muscles, to pay attention to the alterations in neural and non-neural structures, to increase core stability, to enable APAs: the core stability controls the trunk and the head, during the activity of the limbs. You can search ground reaction forces and single leg stance. The single leg stance incorporates the setting of the scapula, essential for reaching.
The descending pathways for motor control from the reticular formation finish at medial parts of the gray matter of the spinal cord, where they influence interneurons, that coordinate the axial and proximal limb muscles.

Postural control involves an anticipatory mechanism, i.e. the “pre-programmed” answers that come before the limb starts moving. For example, when a subject is invited to use their arm to pull a handle, immediately after hearing an acoustic stimulus, the activity of the biceps muscle begins 200 ms after the sound. However, the contraction of the biceps is accompanied by a significant increase of the activity of the gastrocnemius (and other muscles not monitored): the contraction of the gastrocnemius muscle precedes the contraction of the biceps muscle.
These observations demonstrate that the postural control implies a mechanism of anticipation, to provide a preparatory postural support.

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CENTRAL COMMAND → LIMB MOVEMENT → POSTURAL INSTABILITY

pAPA   POSTURAL ADJUSTMENTS ← aAPA
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The postural component forms a frame of postural stabilization for the first voluntary movement. Postural control is anticipatory and responsive, it is influenced by learning, experience, from its context and sensory input. It provides body position in space with the goal of orientation and stability.

The postural orientation provides a vertical orientation to counteract the gravity forces and therefore an active alignment of the trunk and the body towards gravity.

The afferent system for orientation includes:

- the visual system: to establish relationships with objects and space;
- the vestibular system: for information on the position of the head in the space;
- the graviceptor system: located in the bowel. It perceives the orientation towards gravity; it creates a linear acceleration against gravity with propulsion along the vertical line;
- the somatosensory system: it indicates the position of the body’s segments, it identifies the location of the body in the space, it is completed by the exteroceptive informations to project the center of gravity in the base of support.

The process of integration of the various afferent systems creates an internal model of itself, i.e. the body schema.

The postural stability is based on an efferent system of feedforward control, of error correction, of alignment of muscles and joints.

The postural stability is the ability to control the center of mass towards the base of support; it creates maximum verticality and the midline, to perceive and act towards the outside world. Through internal and external perception it creates the prerequisite for stability.

The feedforward mechanisms prepare the body for the perturbation expected from a voluntary movement. They are movements that start but which are not planned. They can be divided into two aspects:

- pAPA (preparatory): they are adaptations of postural tone in response to gravity and displacement;
- aAPA (accompanied): they allow the loss and regaining of the midline in relation to the center of gravity and base of support.
In order to develop and maintain the feedforward control you need to have attention, urinary continence and motivation.

The aAPA and pAPA are demonstrations of the body schema: a muscle must be in the body schema, otherwise the APA cannot be activated.

In patients, the reduced body schema and consequently the changed anticipatory control increase the perturbations during voluntary movement and reactive strategies increase the vestibular response to control perturbation, i.e. associated reactions.

The associated reactions are a reaction to the loss of stability required to maintain the posture or moving. They are a sign of protection or a vestibular reaction to the loss of postural control. The associated reactions limit the ability of interaction of the distal parts with the environment, losing the ability to orientation towards the body and the environment.

If the reactions are used repeatedly they become learned as part of the functional movement and cause a stereotyped behavior that may cause hypertonia and structural changes in the musculature.

So it is important:

- to align the components in joints and muscles;
- to integrate the body schema;
- to increase core stability,
- to make possible the APA.
CASE REPORT

A.E.: 66 years. The woman, who reached retirement age for 7 years, before worked as a picker in a mushroom farm.

She has a husband, who doesn’t cooperate with his wife for the management of the house and in ADL. She has got three children: 1 son, who lives far away, and two daughters, both working. One daughter lives on the ground floor of the family house, while the other will soon return to live in the parental home, due to the recent separation from her husband. The daughters are present and help their mother in the home management, as much as they can. The patient has a reduced social life.

On 15/07/2013 the patient is admitted to the Stroke Unit of Castelfranco Veneto, with the diagnosis of "right ischemic stroke nucleus-capsular (right semi-oval center)." The woman says that for a couple of days she felt a numbness in her left upper limb, but she called the emergency number only on Sunday, when she didn’t manage to walk. During hospitalization hypertension, hypercholesterolemia and diabetes mellitus type II, now treated with drugs, were found. The patient reports that in the past she had suffered from pains, due to inflammation in the joints, not well investigated.

Subsequently, the patient was transferred to the long-term care rehabilitation ward of the hospital of Montebelluna and on 31/07 she entered the Department of Physical Medicine and Rehabilitation. The initial score of the FIM scale was 65/144, while the score of the Barthel scale was 20/100. At discharge, on 26/09 the score of the FIM scale was 98/144, while the score of the Barthel scale reached 65/100.

The patient was admitted to rehabilitation surgery on 30/09/2013 with an initial prescription of 10 sessions of one hour each.

E.A. enters the gym sitting in the wheelchair, pushed by her husband, but to move on her own at home she uses the right leg (the wheelchair has a single platform). On the left foot she wears a brace, called "peromed", while on the upper limb, which is not functional, she uses a brace to support the gleno-humeral joint, because of the shoulder pain during day and night. At home she walks with the aid of a stick for short stretches. For long stretches she uses the wheelchair. The patient reports that during the day she feels restless and needs to change position frequently and in the evening she is very tired.
Sitting on the wheelchair the pelvis falls towards the hemiplegic leg and the trunk is rotated back towards the hemiplegic side. The less affected hand supports the affected arm at the wrist. The face is asymmetrical. During the passage from the sitting position to standing the load is mainly on the right side, with the support of the less affected hand on the arm of the wheelchair.

In the upright position the hemiplegic foot is forward and it does not accept the load (hip and knee are flexed). The right lower limb is extended and bears the load of the body, moving the midline to the right. The trunk is rotated back to left and the arm remains along the trunk with flexion and pronation of the forearm, already showing a sense of heaviness. The upper trapezius muscle is stretched.
Looking at the patient from behind, you can see that the left scapula is protracted, the hip is flexed and the trunk does not lie over the lower limb. The head is rotated to the left.

The right upper limb does not fall along the side, the left elbow is in flexion. The right side seems to bring the weight down, there is no activity against gravity.

While walking with the aid of a stick, the right arm is always close to the trunk, with the elbow flexed and the forearm pronated, so the hand is in front of the thigh, with the fingers in flexion. The trunk is rotated back from left side.

During the single stance of both lower limbs, there is no extension: the body never lies above the lower limb.

From the left side, the start of contact of the foot is not with the heel; during the mid-stance there isn’t any extension of the hip and knee, and then during the "heel off" there is no extension granted.

Even on the right side there is no acceptance of the load and the middle line is moved. With the use of the stick the limits of stability change.
CLINICAL REASONING

ASPECTS THAT INTERFERE WITH THE NORMAL MOVEMENT:
✓ restlessness;
✓ shoulder pain;
✓ loss of asymmetry of the head;
✓ low postural tone;
✓ poor core stability;
✓ ineffective APAs;
✓ inadequate movement of the center of mass above the lower limbs in the stance phase;
✓ associated reactions to upper limb;
✓ reduction of extension and abduction in the hip, with the loss of the lateral tilt in the pelvis in the stance phase.

SHORT-TERM GOALS:
✓ to recover the symmetry of the body, with the maintenance of muscle lengths;
✓ activation of core stability and APAs with the purpose of increasing the postural tone and decrease the shoulder pain;
✓ inhibition of the reactions associated in the upper limb thanks to higher postural tone;
✓ activation of the extensors and abductors of the hip, including the activation of the foot, to have long and strong legs;
✓ to walk by herself without the wheelchair inside home.

LONG TERM GOALS:
✓ walking in autonomy for long stretches;
✓ activation of upper limb, as aid / support for activities with two hands, because she needs autonomy in ADL.
REHABILITATION TREATMENT

In the first session, through stop-standing I make the patient sit with the support of the front table: the positive reaction of the hand contact isn’t possible, because of shoulder pain. In sitting position, I put some towels below the ischial bones to give symmetry and stability: I work to activate the core stability and the drafters of the column to create linear acceleration. I work on the upper limb to bring the scapula in the right place.

At the end of the treatment I manage to get a trunk with a more active postural tone and in standing the lower limbs are more active, long and stronger. Also the line of the scapula is more symmetrical. The upper limb is still heavy and when walking I have difficulty in sustaining it.

BEFORE TREATMENT

AFTER TREATMENT

In the second session, the patient performs the Timed Up and Go (TUG) test with the stick with the result of 34" and without stick with the result of 36 "79 '.

In the upright position the lower limbs have maintained the result achieved and the forearm is less pronated. After the treatment she feels less restless and does not have the need to change position frequently.

The stop-standing is more harmonious and with spatial and temporal summation she sits more easily.
The lower part of the trunk has maintained a good postural tone, but not so well the upper part of the trunk. I decide to work with multiple summation at the thoracic level, getting a good linear acceleration, a good postural tone. In this way I can better see the shortening of the upper trapezius, the protraction of the scapula and the fixation on the right scapula.

I work on the trapeze, on the chest and on the scapula, on the less affected and on the affected part: the objective is to bring the medial border in alignment and the lower corner aligned with the sacroiliac joint. I also work for the realignment of the forearm and hand, to give a shape to the hand.

At the end of treatment, with the patient in the upright position the arm is lighter and I can depart it from the trunk without pain.

At the third session, the patient reports that she has no more pain in the shoulder, not even during the night. At home she can do without the stick for short distances. The legs are long and extended and the arm is light too.

Through stop-standing I lead the patient to sitting position. In sitting I facilitate through the affected shoulder and I active core stability to get to the supine position.
I align and prepare the lower limb with activation of the foot, and then I selectively enable the extension of the hip: the hip is "sucked" in the joint.

Through placing of the upper limb in elevation and with the help of a ball in her hands I activate core stability for the passage supine-sitting, with the lower limb out of bed. In the passage the hip is flexed and then I have to work again for the core stability.

In the upright position the upper limb is still lighter and I can move it away from the trunk. The walking is faster, with less hip flexion.
At the fourth session, the patient reports that she does not use the stick all day at home. After treatment at the foot she feels the support of the foot better. Today, the upper limb is stiffer.

I repeat the treatment of the previous session, with transition from supine to sitting through the facilitation at the hand. The patient doesn’t flex the hip and then the core stability is more active.

Walking is possible by keeping the arm elevated to 90 ° (activities not possible the days before), but it highlights the weakness of the hip abductors.

At the fifth session, through stop-standing, I lead the patient sitting and then supine. I work to activate the CPG, for selective extension of the hip and to get the quadriceps femoris activity.
Then I lead the patient from the supine to the sitting position, where I propose the activity of stand-down, with the support of the right limb on a support, activating the medial gastrocnemius.

Walking barefoot, the support of the foot is on the side of the foot. The first step is still carried with the less affected leg.
At the sixth session I resume treatment for the symmetry of the trunk, because over the weekend the patient has lost the midline.

At the seventh session, through stop-standing I lead the patient to sitting, supine, and then in the right side. Maintaining stability on the core stability and on the lower trunk, with the aid of supports, I work for the left abductors of the hip and to build up the step back.

At the eighth session, I take the treatment in the lateral decubitus and then I lead the patient to standing. With her back supported by the wall and her upper limbs supported by two beds on the sides, I try activities on the affected hip abductors, through activities of right lower limb. The work is hard and the first step, to start walking, is again with the affected leg.
At the ninth session I repeat the activities in one leg stance while standing on the wall. Preparing the postural components across multiple temporal summation I get the chance to move the right lower limb in abduction, by increasing the stance of the left limb. When she starts walking, the first step is carried out with the less affected leg.

At the tenth session the result of the TUG test without a stick is 31" 78 '. Walking is possible with the facilitation on left arm elevated to 90 ° and with the right arm less, still showing weakness in the hip abductors and hip flexion in stance phase.
I agree with physiatrist to continue the treatment sessions. For service requirements, the patient will be taken over by a colleague.
CONCLUSIONS

In the two weeks of working with the patient, the shoulder pain is gone, the right upper limb and foot have less associated reactions, and the patient feels better. The symmetry of the face is improved and the patient feels taller and more toned. At home she walks without the aid of the stick. The test result TUG is improved by about 5 seconds.

I have had many difficulties during treatment sessions.

For service requirements, I wasn’t able to count on the presence of a colleague in the gym, to help me in some moments of the activities. Her husband did not want to be present to treatment either.

Another difficulty was to realize how much I could add: fearing to complete too few tasks in the session, I may have added in an appropriate way to achieve the right threshold of excitability. However, if I do not reach the threshold, I do not get the ability to do the activity!

In the treatment sometime I have had also to go back to recover outstanding achievements. On Monday, I worked to regain the symmetry of trunk lost in the weekend.

The tools and information acquired during the course have been an opportunity to facilitate the patient: the difficulty is figuring out when hands should drive and when they have to leave ("hands on / off").
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