Restoration of Weight Bearing Symmetry in Hemiparetic Patient

Mohamed N. Elbahrawy*, Ehab Shaker and Olfat A Kandil*****
*Department of Physical Therapy for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University.
**Neurology Department, Faculty of Medicine, Cairo University.
***Basic Science (Biomechanics) Misr University for Science and Technology.

ABSTRACT

Postural disorders are disabling consequence of stroke. One of these, is asymmetry of weight bearing, subsequent impairment of balance and falling during activities. Successful management of these problems includes identification of the primary cause as well as applying management strategies which is feasible and directly linked to the ultimate goal. ***Patients and Methods:*** *Twenty patient with cerebrovascular accident at least six months duration, around grade 1 to grade 2 according to modified Ashowrth's scale of spasticity. They were tested for percentage weight bearing using balance master. In addition to functional timed Up / Go test before and after applying a suggested program that consisted of stretching exercise followed by neuromuscular electrical stimulation for latissimus dorsi muscle.* ***Results:*** *the results of this study showed significant increase in percentage weight bearing of the affected limb from 39.75% to 43.86%, and decrease in timed up / Go test from 58.50 to 28.65 seconds.* ***Conclusion:*** *Regaining the symmetry and subsequently steadiness during walking is the ultimate goal of successful rehabilitation with minimizing the duration of treatment and the possibility of chronicity. Redirecting attention of physiotherapist to the postural muscle known as latissimus dorsi is of value in considering this muscle as shoulder girdle as well as trunk muscle having great role affecting posture.*

INTRODUCTION

Balance is an ambiguous term used to describe the ability to maintain or move within a weight bearing posture without falling. Balance can further be viewed as three aspects: steadiness, symmetry, and dynamic stability. "Steadiness" refers to the ability to maintain a given posture with minimal sway[28].

The term "symmetry" is used to describe equal weight distribution between weight bearing components e. g the feet in a standing position. The "dynamic stability" is the ability to move within a given posture without loss of balance. All of these balance components; steadiness, symmetry, and dynamic stability have been found to be disturbed following stroke[20].

For many years authors have described this postural abnormality on subjective bases and clinical judgment[2,6]. Recently measurement techniques have provided quantitative evidence to substantiate clinical observation. Abnormal gait patterns usually lead to postural compensation where the normal segmental weight bearing of the body is widely disturbed. Moreover, posture and postural changes in the form of pelvic or spinal compensation have been reported to result from improper foot and ankle mechanics[28]. So that regaining of symmetry and other components of balance involve many feedback systems including indirect link between proximal and distal joints[2].

The resulting postural defect in hemiplegic patients is adapted by neurophysiological interplay of the musculoskeletal system. This modified activity may be compromised after functional correction[28]. The common initial goal of physiotherapy after stroke is to improve the patient capability of correcting weight distribution of their affected limb; as the transmission of weight on the hemiparetic leg is essential in correcting the gait pattern as it allows the non affected leg to be moved and consequently a step to be taken[22].

The integrity of body weight transmission is achieved by the functional cooperation of trunk muscles (fig. 1); lateral abdominal muscles, latissimus dorsi and erector spine muscles that mantain spinal alignment[21].

The postural compensations are the result of a series of changes on a time continum from the onset of stroke, there is some disturbance of vertebral mechanics since the weight bearing asymmetry is due to back muscles imbalance[8].

The latissimus dorsi is a wide sheat of muscles which extend on the back from the top of humerus to the lumbar spines and pelvis (fig. 2). Also it is an important back muscle by its attachment to the thoracolumbar fascia and through lumbo-sacral aponeurosis from spinous processes of last six thoracic vertebrae, five lumbar vertebrae,and sacrum,in addition to the outer lip of posterior part of ilium. This origin gathered to insert in the floor of bicipital groove of humerus[15]. Both latissimus dorsi and abdominal muscles must be stretched for postural correction. Latissimus dorsi muscle is considered as trunk muscle which tightened as a result of hypertonicity in stroke[2].

Further, latissimus dorsi contributes in abnormal feed back system; in stroke patients; to the spine posture that consequently causes asymmetrical weight bearing.

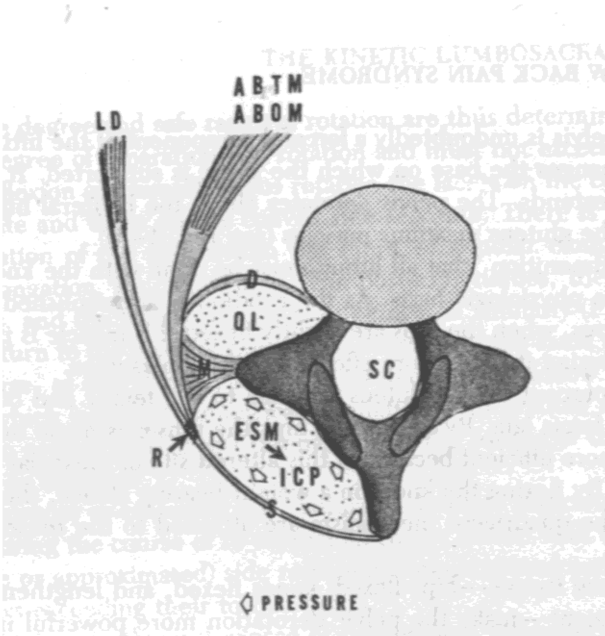

Fig. (1): Diagram revealing the spinal canal (SC), abdominal muscles, tense middle layer of thoraco-lumbar fascia where the latissmus dorsi (LD) represent the superficial layer. (Quated from cailliet, R. 1980)[5]

QL	:	*quadratus lumborum muscle*
ESM	:	*erector spinae muscle*
ABTM	:	*abdominal transverse muscle*
ABOM	:	*abdominal oblique muscle*
LD	:	*latissimus dorsi muscle*

Aim of the study

The aim of the current study was to estimate the value of the suggested program for latissimus dorsi muscle in distribution of weight bearing symmetry in vascular hemiparetic patient.

SUBJECT AND METHODS

Subject

Twenty subjects were included in this study with a characteristic values summarized in table 1 with an age bracket (46-58years) with an average of 51.45 ± 3.516. Both sexes were assigned with a total 12 males and 8 females (Fig. 4). The history of hemiplegia is back dated to a range from 6 to 11 months with an average duration of illness 7.65 ±1.598.

Inclusion criteria

1- Cerebro-Vascular Accident (CVA) at least 6 months before study.

2- Grade 1 to grade 2 Modified Ashowrth's scale of spasticity[4].

3- The patient was able to walk independently for 15 minutes and to stand independently for at least 2 minutes.

4- There was no history of injury or trauma to the back and lower extremities.

5- Duration of illness ranged from 6-24 months.

6- All patients gave informed consent to participate in this study.

Exclusion criteria

- Cerebellar or brainstem lesions; significant verbal, visual, dysfunction.
- Marked deficits of balance (less than 35\56) according to Berg balance scale.
- A score of 21 or less on the modified Folstein mini mental state examination.[9] (the normal score ranges between 24-28)[9].

Measures and Instrumentation

Percentage weight bearing test was measured using smart balance master system with software version 7 located within the Neurology Department at the Kasr El Aini Hospital, Cairo university. This system is composed of two adjacent force plates, each with two strain gauges. These force plates were connected to an IBM computer with monitor. The monitor provided visual feed back of the position of a subject's center of gravity. The computer system had an internal calibration system for the balance master, which was automatically activated when the machine was turned on.

Each subject was asked to stand on the balance master platform according to the manufacture's standard protocol. Subjects were instructed to stand erect, keep their feet in the correct position. Three trials were carried out, and the computer gave the average for every patient.

Functional measure:

The timed "Up and go" test[17]: Subjects were seated in an arm- rest chair. They were instructed to stand, using the arm rest if they need to and walk as quickly and safely as possible for a distance of 3 meters. Subject then would change direction and walk back to the chair and sit down. A stop watch was used to time the activity as the subject's back just start to be away of the seat back to indicate the intension to move up, till the end of the cycle where they are returning their back in contact with the seat back. Following a practical trial to exclude the effect of learning process; three trials were done to get the average time as a number of seconds to be used in descriptive and inferential statistics.

Procedures for intervention:

1- Stretch-exercise of latissimus dorsi:

Subject position :Subject was lying on one side position with the affected side up, and fixed in full shoulder elevation, the affected lower extremity rested on small cusion at the level of knee while the hip in flexion approximately 45º.

The therapist stands opposite the shoulder level behind the subject, one hand holds the upper Limb in full elevation while the other hand applying firm and sustained stretch towards the couch at the level of pelvic crest.

This maneuver were held for ten minutes then released for 5 minutes, and repeated three times. Following this manual stretch, neuromuscular electric stimulation was applied on latissimus dorsi on the same side for 20 minutes. Treatment program was applied every other day for a total of four weeks.

2- Neuromuscular electrical stimulation unit:

Model Number UP8P4, manufactured at UK. It produces asymmetrical biphasic pulse width of 300ms, stimulation frequency: 10-100 Hz, relaxation time 0.5-50s. Time 0.5-10s, treatment timer ranged 5-60 and continuous (per minute) and rise time 400 ms.

Electrode placement: Patients skin was cleaned (using cotton and alcohol to decrease the skin impedance for electrical stimulation), then putting conducting gel and tight the electrodes by adhesive plaster. While patient in sitting position, one electrode are applied around 3 cm lateral to inferior angle of scapula (motor point of the muscle) as the motor point is a point on the skin surface at which maximum muscle contraction can be achieved with minimum energy, and the other electrode applied 10 cm. lateral to the tenth thoracic spine as it gives rise to the fleshy fibers[18].

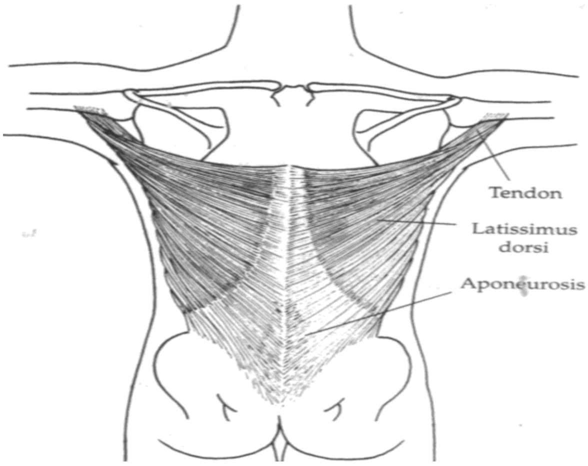

Fig. (2): The latissimus dorsi muscle (Quated from cailliet, R (1980)[9].

RESULTS

Concerning the base line inclusion criteria, the mean value for Berg Balance test, Folestine Modified Minimental state and up /Go test are presented in table (3) and illustrated in figs (4 and 5).

Regarding mean values of percentage weight bearing test between affected and non affected limb, the results revealed a very highly significant improvement (P<0.01). also regarding mean values of timed up /go test pre and post physical therapy intervention the result revealed highly significant improvemt from 58.05/second to 28.65 second respectively (P<0.01).

Table (1): General characteristics of patients.

Age	X (51.45)
	SD (3.516)
Duration of illness	X (7.65)
	SD (1.598)
Sex	Male (12)
	Female (8)
Berg balance test	X (45.5)
	SD (3.59)
Modified Ashowrth's scale	Grade 1 (2)
	Grade 1+ (9)
	Grade 11 (9)
Folestine Modified Mni Mental state	X (23.35)
	SD (0.74)

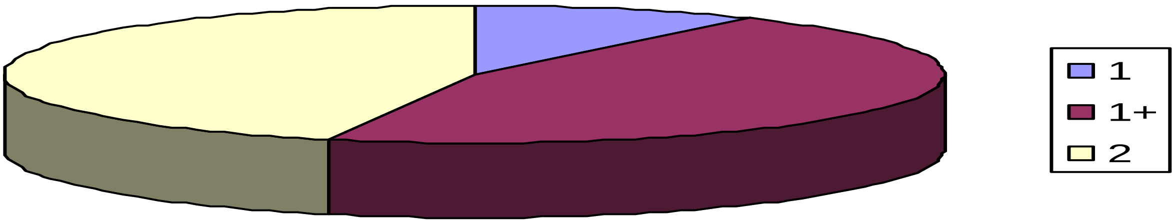

Fig. (3): Modified Ashowrth's scale.

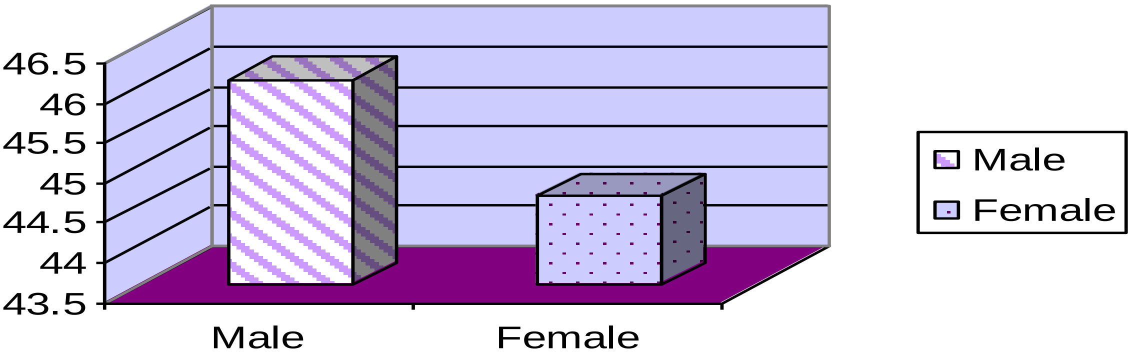

Fig. (4): Berg balance test base line findings.

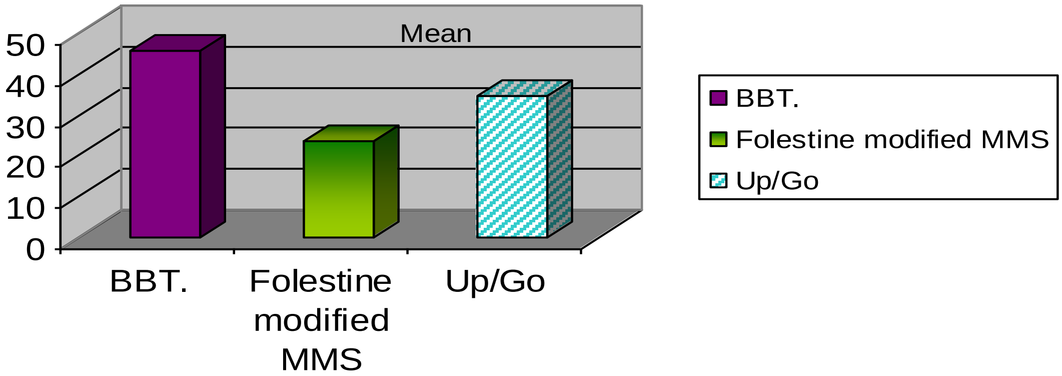

Fig. (5): The base line findings concerning the static and dynamic balance.

Table (2): Displays the significant improvement consequent to the effects of rehabilitation program on the correction of the weight Bearing in 20 hemiparetic patient with an increased mean value from 39.75±71 to 43.8±1.5.

Wt. bearing	N	Mean	Std. D.	P value
Affected limb Before	20	39.75	1.71	<0.0001***
Affected limb After	20	43.80	1.50	

***High significant effect with P value < 0.0001
Weight bearing pre-post rehabilitation program

Table (3): The scores in timed Up/Go test and weight bearing scores is compared between pre and post intervention are shown and presented in fig. 6. The time in up/Go test is significantly decreased from 58.5 to 28.65±1.38.

Variable	Up/Go		Weight Bearing	
	Mean	SD	Mean	SD
Pre	58.05	2.163	39.75	1.71
Post	28.65	1.386	43.80	1.50

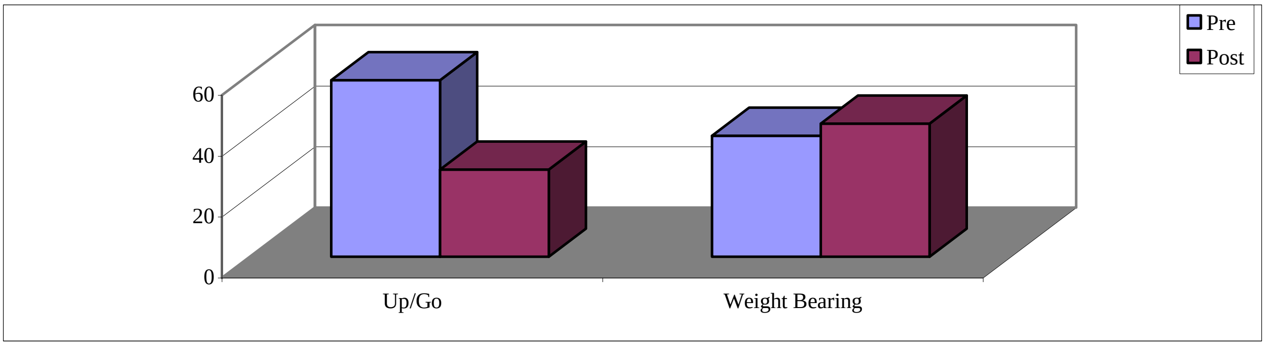

Fig. (6): Comparison between pre and post mean value of timed up /go test and percentage weight bearing test.

DISCUSSION

The piled observation discloses a respectable degree of improvement in weight bearing symmetry as well as timed up/ go test in hemiparetic stroke patients.

In this study, the application of latissimus dorsi stretch in conjunction with neuromuscular stimulation were effective in restoration of weight bearing of the affected limb from 39.75% to 43.86% and decrease in timed up/go test from 58.5 to 28.65 seconds (table 3).

The findings of this study agree with Dekstein et al., who reported that the function of the superficial abdominal muscles and of the latissmus dorsi is affected by stroke, as they found that the elctromyographic activity of rectus abdominus and latissmus dorsi on the affected side of the body was reduced and delayed relative to the unaffected side in stroke patients[8].

The change of speed or cadence is affected primarly through viewing the moving inertia which consequently is affected by lateral trunk stability[19].

Alignment of the body refers to the arrangement of body segments to one another, as well as the position of the body with reference to gravity and the base of support[25].

So, alignment of body segments over the base of support determines to a great extent the effort required to support the body against gravity. It can be interpreted asymmetrical alignment in sitting and standing of hemiparetic patient, this patient tends to stand with weight displaced toward the uninvolved side. Since latismus dorsi stretching and neuromuscular electrical stimulation enhance proprioceptors information about alignment of trunk which improve stability and regain symmetrical distribution of weight bearing on lower extremities.

The latismus dorsi is one of the strong shoulder adductors in addition to the back muscles, accordingly, these muscles must be stretched in postural correction program. Moreover, the latismus dorsi forms the superficial layer of the fascia forming a compartment, where tension of the latismus dorsi and abdominal muscle cause an increase in caudo -cervical tissue tension[27].

Different approaches have been advocated to retrain balance function, of these approaches a study based on feedback system using auditory and visual input signals in a force platform[2].These systems use the monitor as a visual biofeed back for retraining the restoration of weight bearing symmetry. In this study, weight bearing symmetry based on the suggested physiotherapeutic protocol that was focused on latismus dorsi muscle as a postural back muscle; usually spastic in hemiparetic patient. This approach was designed to solve the motor control problem allowing proximal selective joint excursion and muscle use.

For the highest score on the Berg Balance Scale[1], a subject is supposed to stand unsupported for at least 10 second on one leg, while in Bohannon's ordinal balance scale,[3] 30 second are required, and in Tinetti's Balance Subscale[26], a subject has an alleged normal balance if he/she is able to stand on one leg without support for 5 seconds.

One-leg stance (OLS) is a frequently used clinical tool for assessment of balance in persons with various balance disorders[1,3,26]. Control of body posture and balance is a coordinated process in which multiple subsystems and environmental factors interact to maintain balance[10]. The ability to stand on one leg is used alone or as an item in clinical balance tests assessing postural steadiness in elderly[1,3,26]. The difficulty of keeping the centre of mass above the centre of pressure is reflected in the variability of the ground reaction forces[12,23].

The evidences describing postural compensation were significantly more frequent among hemiparetic patient. The findings of the current study were in consistent with the above stated view. In hemiplegic patient; postural muscles; tend to suffer spasticity after stroke including latissimus dorsi, erector spinae, quadratus lumborum. The extensive attachment of latissimus dorsi demonstrate its multifunctions which includes shoulder and trunk joints as main keys of axial movements. Spastic latissimus dorsi may disturb the symmetrical weight bearing distribution on feet, as it adjust the spine to the other segments of the axial and appendicular skeleton keeping a good alignment. Moreover, trunk muscles are crucial to postural stability. Postural deficits are frequently observed in clinical practice often in brain lesions and are considered as a key issue in rehabilitation programs[2]. The direction of the center of pressure displacement depends on shifts of both arm segments in relation to the trunk. If the encountered displacement of the trunk is of insufficient amplitude to compensate for the shift of the mass of both arms, the center of pressure would move in the same direction as the arm movement[23].

Sensorimotor training (SMT) emphasizes postural control and progressive challenges to the sensorimotor system to restore normal motor programs in patients with chronic musculoskeletal pain. Patients progress through static, dynamic, and functional phases using simple rehabilitation tools such as balance boards, foam pads, and elastic bands[13].

Janda's approach to chronic musculoskeletal pain was that certain muscle groups, the "postural" and "phasic" are pre-disposed to tightness or weakness, respectively, based on their function and control by the CNS[14]. This classification was based on the assertion that these two groups served different functions in human development and movement patterns, and that their balanced function was essential to normal movement. Often, the "postural" muscles would respond to dysfunction with increased tightness, while the "phasic" muscles would respond with weakness, creating characteristic muscle imbalance syndromes.

The author suggested that the sensory information coming into the CNS must be optimal at three locations in the body due to their large amounts of proproiceptors: the foot, the sacroiliac (SI) joint, and spine. The goal of SMT is to increase proprioceptive input of these three areas in order to stimulate subcortial pathways and facilitate automatic coordinated movement patterns. Therefore, it is vital to ensure proper positioning of the joints at these three key points during any exercise. This illustration could explain the improvement in the symmetry of weight bearing noticed in the present work.

The next key point in postural stability is the SI joint[11]. The lumbo-pelvic region must be maintained in a "neutral" position, neither too lordotic nor too kyphotic. It is important that any dysfunction of the SI joint should be corrected prior to initiating SMT because of its role in proprioception. This helps to ensure proper length-tension relationships of the joint mechanoreceptors sending information on posture to the CNS from the lumbo-pelvic region.

Concerning placement of electrodes parallel to the longitudinal alignment of the muscle fiber length increases the tolerable muscle torque by 64% as compared to alignment of electrodes in a 90º orientation to the muscle fibers[16,18]. Meanwhile, the direction of electric current flow should be parallel to the direction of muscle fibers. Moreover, following neuromuscular stimulation of the muscle, voluntary activation improves and enable the process of muscle reeducation[7].

Ultimately, the results of this study support that the used program (stretch-exercise of latissimus dorsi and neuromuscular stimulation) helps patients to reestablish symmetrical postural alignment, consequently improve symmetrical weight bearing on both affected and non affected foot.

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الملخص العربي

استعاده تماثل تحميل الوزن على القدمين في مرضي الشلل النصفي

هدف البحث : تحديد قيمه برنامج علاج طبيعي مكون من شد للعضلة الوسيعة الظهرية يتبعه تنبيه كهربي عضلي عصبي في استرجاع تماثل تحميل الوزن على القدمين في مرض الشلل النصفي الناتج عن السكتة الدماغية . أجريت الدراسة على عشرون مريضا من الجنسين يعانون من شلل نصفى نتيجة للإصابة بسكتة دماغيه من مستشفى القصر العيني جامعه القاهرة وقد تم علاج المرضى ببرنامج تأهيلي خاص مكون من تمرينات شد للعضلة الوسيعه الظهرية يتبعها تنبيه عصبي عضلي على الجانب نفسه . وقد أسفرت النتائج عن تحسن ملحوظ في تماثل التحميل على الساقين وأيضا تحسن في مقدار الوقت المستهلك في اختبار حركه الوقوف ثم المشي لمسافة محدده والجلوس مره أخره . وقد أثبتت النتائج أن هذا البرنامج العلاجي يؤثر تأثيرا أجابيا على درجه تحسن المريض واسترجاع تماثل تحميل الوزن على القدمين .