Trunk Control in Relation to Ventilatory Function in Chronic Hemorrhagic Stroke Patients

Ahmed M. Elshinnawy¹*, Nasr H. Khalil²

¹* Physical Therapy Department for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Modern University for Technology and Information, Egypt.
²Head of department of Chest Diseases, Ahmed Maher Teaching Hospital, Egypt.

Corresponding Author: Ahmed M. Elshinnawy, Faculty of Physical Therapy, Modern University for Technology and Information, Egypt

Abstract

Background and purpose: Stroke can have high varying effects on patient’s trunk control and ventilatory function. The current study was done to assess the relationship between trunk control and ventilatory function using computerized spirometer in chronic hemorrhagic stroke patients.

Subjects: twenty five hemorrhagic stroke patients from both sexes (17 male and 8 female) were participated in the study. The age ranged from 40-60 years. Methods: Subjects were assigned into one group “Patients with chronic hemorrhagic stroke”.

Procedures: Trunk control was assessed using Trunk impairment scale and ventilatory function was assessed by using spirometer.

Results: The results showed that there was a significant moderate direct relationship between overall score of Trunk impairment scale and peak expiratory flow and maximum voluntary ventilation.

Conclusion: it was concluded that the relationship between trunk muscles and ventilatory function appear to be significant in chronic hemorrhagic stroke.

Key Words: Stroke, trunk control and ventilatory function.

INTRODUCTION

Stroke is the rapid loss of brain function which has many causes as hemorrhage1. It should not be considered an isolated event but as a clinical consequences of progressive underlying vascular disorder2. Stroke is classically characterized as a neurological deficit attributed to an acute focal injury of the central nervous system by a vascular cause, including cerebral infarction, intracerebral hemorrhage, and subarachnoid hemorrhage, and is a major cause of disability and death worldwide³. Decrease motor control of trunk muscles is a key problem area in stroke recovery4. Trunk control is one of the most important functional outcomes after stroke⁵. Trunk is the central key point of the body. The essential commitment of the trunk compartment muscles is to balance out the spine and the trunk compartment⁶. Trunk muscles participate in activities involve either the trunk itself and/or the limbs. They may function as: (1) prime movers or synergists in voluntary trunk movements; (2) automatic responders to unexpected body and/or limb perturbations; (3) anticipatory postural adjusters of the trunk during temporary or ongoing activities of the limbs⁷. Despite the fact that hemiplegia influences one-sided appendage action, there is a possibility to diminish the capacity of trunk muscles on both sides of the body influencing the proximal control. The loss of proximal adjustment influences the appendages significantly in that the arm and leg must be moved in spastic cooperative energy designs. Loss of specific movement in these muscle gatherings of trunk neglects to empower the patient to settle his thoracic spine in augmentation while utilizing lower abs as a part of confinement, which is reflected in strolling⁸.

According to the structure which affected in stroke, the respiratory disorder appears. The maintenance of normal ventilation depends on the intact functional components of the neuromuscular system. Ventilatory disturbances occur when the diseases affect the nervous system, the muscle routes or the thoracic cage, despite the lungs being normal⁹. The affection on the respiratory system due to stroke relies on upon the structures influenced by the injury. The maintenance of normal ventilation depends on the intact functional components of the neuromuscular system. Ventilatory disturbances occur when the diseases affect the nervous system, the muscle routes or the thoracic cage, despite the lungs being normal¹⁰. Stroke may
disrupt breathing either by causing a disturbance of central rhythm generation, interrupting the descending respiratory pathways leading to a reduced respiratory drive, or causing bulbar weakness leading to aspiration. Respiratory impairment may complicate ischemic stroke in three setting (1) it may occur as a direct result of lesions impacting brain stem control of respiration, with loss of pharyngeal tone as well as cough, swallow, and gag reflexes. (2) Consciousness may be diminished, resulting in relaxation of the pharyngeal musculature and tongue and suppression of cough and gag reflexes, the risk for respiratory impairment in association with large hemisphere stroke increases after a few days delay, as the cerebral edema intensifies. With progressive brain stem dysfunction due to herniation, a complete loss of control of pharyngeal musculature and protective reflexes is present. (3) Respiratory compromise may be cause by aspiration or systematic complications as pneumonia, pulmonary embolism or pulmonary edema. These complications should be considered any time a sudden change in respiratory status occur in patients with acute ischemic stroke.

Method Design
This was an observational, quantitative and descriptive study. It was performed at the outpatient’s Clinic of Neurology, Kasr Al-Aini Hospital, Cairo University, from april 2013 to December 2013. All patients or their legal representatives signed two copies of an informed consent form before the beginning of data collection. The present study was approved by the ethical and research committees of the involved institutions.

Participants
twenty five hemorrhagic stroke patients were included in the study.

General Characteristics
Include 25 patients of both sexes (17males68% and 8females32%) with age ranged from 41 to 58years with the mean value of (50.1±8.76). The distribution of the right-left hemiplegia is 12 patients have right affection and 13 patients have left affection. The spasticity ranges from 1+ till 2 (10 patients were 1+ and 15 patients were 2). The duration of illness ranges from 10 months till thirty 3 year with mean value (19.9± 6.33) months, as shown in Table (1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Min – Max</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>50.1±8.76</td>
<td>41-57</td>
<td>1.27</td>
<td>0.212 N.S.</td>
</tr>
<tr>
<td>Weight</td>
<td>82.66±6.27</td>
<td>73 – 80</td>
<td>-1.27</td>
<td>0.212 NS</td>
</tr>
<tr>
<td>Height</td>
<td>168.8±5.34</td>
<td>165 – 179</td>
<td>-0.25</td>
<td>0.802 NS</td>
</tr>
</tbody>
</table>

As indicated from descriptive data of all patients, patients participated in this study were homogenous concerning weight and height.

Inclusion criteria: Patient’s ages ranged from 40 to 60 years old. They were with first onset unilateral ischemic stroke. The duration of illness ranged from 10 months to 3 years. The muscle tone grade either 1+ or 2 according to Modified Ashworth scale (Appendix II). Patients were with normal or corrected vision (e.g., glasses or contacts) to see spirometer screen and get a good visual feedback. Patients were with good cognition that enables them to understand the requirements of the study.

Exclusion criteria: Patients with any orthopedic or chest disorders that affect trunk muscles control or cause respiratory disorders were excluded from the study. Patients with impairments of deep sensation. Patients who cannot follow instructions as sensory aphasia, blindness and deafness. Patients with cognitive and psychiatric disorders. Patients with recurrent stroke. Patients who had participated in respiratory exercises as diaphragmatic breathing exercises in last 6 months.

Equipment:
1- Trunk control evaluated by using the Trunk impairment scale (TIS)
2- Ventilatory function evaluated by using Computerized spirometer (ZAN 100 handy II).

Procedure:
Trunk control was evaluated through the Trunk Impairment Scale (TIS)12. The TIS has three subscales: static sitting balance (with three items), dynamic sitting balance (with 10 items) and co-ordination (with four items). The TIS score ranges from 0 to a maximum of 23, which represent no and total control, respectively. In order to perform the tests, the patients remained sitting on a stretcher, without supporting the trunk and the upper limbs. If the arm was hypertonic, the position of hemiplegia was taken as the starting one. The spirometric data were collected through a computerized spirometer where the individuals should be in the same position as described above. The test followed the recommendations described in the Guidelines for ventilatory Function Tests13. The participant was instructed to inhale as much as possible and then do a sustained, quick exhalation till ordered to stop. The experimenter demonstrated the procedure before its being performed by the participant. In addition to avoid unwanted air release there was a nasal clip. Data of three expiratory maneuvers were collected, with a 1-minute interval in between them, using the best values obtained for PEF and MVV. The consistence of the measures was confirmed by using a difference smaller than 10% between the performed maneuvers. Percentage values relative to the predicted indexes were used for age, weight, height and sex of the tested individual, according to the Knudson’s equations.

Data analysis
For the statistical analysis of the data, Pearson’s correlation test was used for parametric variables, with the results expressed as means and standard deviation, and Spearman’s correlation was used for non-parametric variables, with the results expressed as median and 25th–75th percentile. A p < 0.05 was taken as statistically significant. The data were statistically processed with the Statistical Package for Social Science SPSS 10.0 (SPSS Inc., Chicago, IL, EUA).

Results
I-Correlation Tests
1- Peak Expiratory Flow PEF
Correlation tests between the peak expiratory flow and the overall trunk impairment scale:
Table (2): Correlation between the values of the peak expiratory flow and the overall trunk impairment scale

<table>
<thead>
<tr>
<th>Overall trunk impairment scale</th>
<th>Actual peak expiratory flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>14.7 ± 3.2</td>
</tr>
<tr>
<td>Minimum – Maximum</td>
<td>7.2 ± 0.8</td>
</tr>
<tr>
<td>Correlation Spearman Rho(r)</td>
<td>0.587</td>
</tr>
<tr>
<td>p-value</td>
<td>0.034</td>
</tr>
<tr>
<td>Level of Significance</td>
<td>Significant moderate direct relationship</td>
</tr>
</tbody>
</table>

2- Maximum Voluntary Ventilation MVV

Correlation tests between the maximum voluntary ventilation and the overall trunk impairment scale:

Table (3): Correlation between the values of the maximum voluntary ventilation and the overall trunk impairment scale

<table>
<thead>
<tr>
<th>Overall trunk impairment scale</th>
<th>Actual maximum voluntary ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>14.7 ± 3.2</td>
</tr>
<tr>
<td>Minimum – Maximum</td>
<td>53.4 ± 9.7</td>
</tr>
<tr>
<td>Correlation Spearman Rho(r)</td>
<td>0.426</td>
</tr>
<tr>
<td>p-value</td>
<td>0.032</td>
</tr>
<tr>
<td>Level of Significance</td>
<td>Significant direct moderate relationship</td>
</tr>
</tbody>
</table>

Discussion

The point of this study was to evaluate the relationship between trunk muscles and ventilatory function chronic hemorrhagic stroke patients. The result of this study was explained by Grosselink et al. (2000) and Marcucci et al. (2007) whom demonstrate that even if expiration is a passive process, patients with cerebrovascular diseases are not able to perform it efficiently, as the abdominal muscles, which are the primary agents of forced expiration, present a remarkable loss of muscle activity and tonus. The result of this study was explained also by Sutbeyaz et al., (2010) who reported that Stroke is accompanied by sensory changes, including cognitive, visual, perceptual, and language, as well as changes in respiratory muscles, the latter being important and yet little discussed in the literature. In the current study, there was significant decrease in trunk control and ventilatory function (especially PEF) in chronic hemorrhagic stroke patients. The result of this study agreed with Marcucci et al. (2007) who reported that one of the possible reasons for the significant relationship between trunk control and PEF, except for the rectus abdomens, all the other muscles of the abdominal wall is inside the central aponeurosis, which is connected to the Alba line. Thus, each hemi-side dependent on the other for the occurrence of an effective muscular action. This is because the trunk flexors of stroke patients present motor alterations in the abdominal rectum of the paretic side and perform compensations through the external oblique muscles. When these muscles are activated, the affected side in the abdominal wall elongates, not offering sustentation to the muscles that are contracting. These results were supported by Pizzi et al. (2011), who reported that in a few weeks after stroke, there may be alterations to the muscular tonus and changes to the viscoelastic properties of muscles, which interfere with the biomechanical functioning of the thorax and may lead to loss in the ability and performance of the respiratory movements and trunk. Hart et al. (2005) observed that the use of an orthopedic belt stabilizing the abdomen and trunk reduces the functional residual capacity, increasing the PEF, decreases abdominal complacency, improving diaphragm performance and diminishing the sense of respiratory effort in patients with spinal cord trauma. The present study seems to confirm this statement,
because the participants with higher TIS scores — i.e. with better postural control — presented higher PEF values. These results suggest that individuals with impaired axial control are likely to present some impairment in the respiratory dynamic because of the weakness of the muscular structures controlling it. The obtained results came in agreement with Dickstein et al (2011)\(^\text{25}\), who evaluate the correlation between trunk muscles, ventilatory muscle strength and ventilatory function in individuals who suffered chronic stroke. They reported that there is a statistically significant correlation was found between TIS and PEF. This study revealed a significant relationship between trunk control and PEF, this result agreed with Marcucci et al (2007)\(^\text{15}\), whom evaluated the relationship between trunk control using TIS and ventilatory function using spirometer. They approve that there is PEF, which presented a significant relation with TIS, perhaps because it is a result of the force peak exerted by the expiratory muscles. The obtained results agreed with Almeida et al., (2011)\(^\text{20}\) who evaluated the effects of hemiplegia on ventilatory function in 20 patients with chronic stroke compared to 14 healthy subjects. Results have shown that individuals with stroke had significantly reduced values of PEF. They concluded that in addition to the breathing pattern changes, patients affected by stroke may also show decreased ventilatory function. Resultsof this study came in agreement with Swanney et al. (2008)\(^\text{21}\) who described the occurrence of a decrease in abdominal muscle activation after the onset of stroke, and this modifies the thoracic cage positioning, which tends to remain in an inspiration position. In this framework, the respiratory muscles do not work efficiently, leading to a loss of respiratory function in patients with hemiparesis/hemiplegia. Also the result of this study agreed with Sutbeyaz et al., (2010)\(^\text{22}\) who reported that the reduction of the muscular respiratory force may also be related to the fact that stroke individuals are more inactive due to their physical conditions. The result of this study agreed with Ward et al., (2010)\(^\text{23}\) who reported that respiratory function is also impaired, since the trunk muscles, in addition to being responsible for the stability and mobility of the trunk, also act in breathing control. The result of this study agreed with Xiao et al., (2012)\(^\text{24}\) who compared the ventilatory function of adults following their first stroke with established normal adults standards to explore whether pulmonary function is decreased or not. There was a significant different between predicted and actual pulmonary function test values. In this study there was a significant difference in overall score of TIS in acute and chronic group. This was agreed with Karthikbabu et al., (2011)\(^\text{25}\) who evaluate trunk muscles using Trunk Impairment Scale (TIS) and reported that the trunk muscles are impaired on both the sides of the body in patients with stroke. The authors reported also that there is decrease in the trunk control due to weakness of trunk flexor-extensor and bilateral trunk rotator muscles by means of isokinetic dynamometer muscle strength testing in patients with stroke, when compared to that of age matched healthy controls. Also the result of this study concerning the overall score of trunk impairment scale was proved by Monaco et al., (2010)\(^\text{26}\) who assure that there was a significant decrease in trunk control using TIS. The result of this study agree with Verheyden et al (2006)\(^\text{27}\) who reported that stroke patients show a significant decrease in the level of their trunk muscles control performances. This result of the study disagree with Cala et al. (2011)\(^\text{28}\), who find that there is no relation between trunk muscles and ventilatory function in this series of individuals who suffered from stroke.

**Conclusion**

Through the results of the study it could be concluded that overall score of TIS is related to ventilatory function especially PEF and MVV in stroke patients.

**Acknowledgment**

I would like to express their appreciation to all Neurology Department for their support and co-operation, and to the patients who participated in the study

Conflict of interest: None.

**References**


21 Swanney MR, Rupple G and Enright PL. Using the lower limit of normal for the FEV1/FVC ratio reduce the misclassification of airway obstruction, 2008; 63(12):1046-51.


