

Feasibility of Early Physical Therapy Program In-Hospital Patients with Acute Ischemic Stroke

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Abstract

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BACKGROUND AND PURPOSE: Clinical practice guidelines for patients with stroke recommend early stroke rehabilitation at acute stroke unit care. The purpose of the study is to determine the feasibility of the application of feedback breathing device for respiratory training during the acute period in patients with ischemic cerebral stroke and appropriate program of physical therapy.

MATERIAL AND METHODS: Seven patients in acute period – not later than 48 hours after the accident with light to moderate stroke severity under the NIHSS scale. The applied study methods are the following: functional respiratory evaluation, inspiratory capacity with incentive spirometer device, assessing diaphragmatic movement by ultrasonography.

RESULTS: Better results in Forced Vital Capacity, Peak Expiratory Flow, inspiratory capacity and ultrasonography have been observed.

CONCLUSION: An early targeted impact on respiratory disorders in patients with ischemic cerebral stroke is applicable. To determine the clinical significance larger studies are needed.

Introduction

A number of authors propose indications and recommend early start of the rehabilitation process (between 24 and 48 hours after the accident) to prevent and minimize the risk of extracerebral complications and promote functional recovery [1-4]. It is believed that the aggressive detection and treatment of secondary complications, including inactivity related complications, contribute to benefits and that the majority of complications during the acute period may be avoided through early inclusion of physical therapy [5]. There are evidences of the benefits in terms of the functional recovery during this period [6]. There are many differences in recommendation for physical therapy in acute period

and therefore there are significant contrasts in the application in practice. Some studies have shown that early rehabilitation after stroke differs markedly in parts of the world [7]. Guidelines recommend implementation of early mobilization: out of bed within 24 hours and augmented exercise therapy time at minimum dose of 2 times 20 minutes of exercise therapy per day to prevent inactivity complications and to improve long-term outcomes [1] or position change in 2 hours and breathing exercises [8]. Despite the variation, a consensus has been established with regards to the importance and the positive impact of early physical therapy in patients with a cerebral vascular accident. One of the most important tasks of physical therapy is preventing complications to the cardiorespiratory system. The recommendations for

appropriate method are disputable, but in Bulgaria the application of respiratory exercises and repositioning in bed are emphasized [9]. Relatively little is known about the effect of stroke on respiratory muscles function and strategies to improve it. There are a number of unspecified, non-clarified or objectively unproven issues, mainly of methodological perspective, about the application of physical therapy during the acute period in patients with stroke [10].

The aim of this study was to determine the feasibility of the application of feedback respiratory training device during the acute period in patients with ischemic cerebral stroke and appropriate program of physical therapy.

Material and Methods

Seven patients in acute period – not later than 48 hours after the accident and after the neurologist determines mobilization is indicated, were included. Patients were admitted to acute stroke unit in Vth Multiprofile Hospital for Active Treatment – Sofia, Bulgaria. Subjects were collected in 2013, voluntarily attended. Four men and three women of average age of 70.5 ± 5.38 years with light to moderate stroke severity under the NIHSS scale (from 7 to 14 points) and with 20 points Glasgow-Liege scale have been monitored. All the patients were with ischemic stroke (computed tomography scan confirmed), four are right paretic side and three left paretic side. Five of the patients had hypoesthesia, two had no sensory abnormalities. All the patients were able to understand instructions, perform commands and spirometry, without apparent cognitive impairments, decompensated diabetes or high functional class heart failure, no patient was overweight, none had scoliosis or any other abnormalities of the vertebral column, 3 of the patients were ex-smokers. Before therapy all subjects had been given verbal explanations and had signed informed consent statement approved by the local Ethical Committee.

The outcome measures are the following: functional respiratory evaluation – forced vital capacity (FVC), forced expiratory volume at one second (FEV_1), peak expiratory flow (PEF) were measured through a portable spirometer (Vitalograph Micro Spirometer, Vitalograph Ltd, Ireland). Inspiratory capacity (IC) measured with the device Coach2 Incentive Spirometer, measured in ml, rounded to the nearest 50 ml. All pulmonary function measurements were taken after three attempts, the best achievement is reported. Assessing diaphragmatic movement by ultrasonography published already [11, 12] were applied with Fukuda UF-750 XT ultrasonography system with a 3.5 MHz sector transducer. Symmetric intercostal probe positions were chosen between the midaxillary and midclavicular lines. Both hemidiaphragms were examined in a longitudinal plane that included the maximal renal bipolar length,

and craniocaudal movement of the posterior muscular crus of each hemidiaphragm was measured in three consecutive respiratory cycles of both spontaneous and deep respiration. The liver was used as the acoustic window on the right; the spleen was used as a window on the left. All scans were performed by one investigator. The three measurements are conducted in lying position with raised upper part of the trunk from 30° to 45° .

The feedback breathing device for inspiratory training (Coach2 Incentive Spirometer) is applied to all patients with the instruction to make 5 repetitions with 1 to 3 minutes rests between them, at least 4-5 times a day, every day of the week, for 10 days. After discharge of acute unit, the respiratory training with device continue as a home-based training. An indication for termination of the training is a change in the breathing pattern with inclusion of additional respiratory muscles, paradoxal breathing, etc.; severe fatigue or dyspnea; patient's desire to discontinue.

Physical therapy is applied to achieve an optimal level of functional recovery. Choosing the most effective therapeutic exercises depends on the determined deficits, needs and expectations of the patients. In this study there are combined approaches for solving certain tasks and achieving the optimal level of recovery. We group the applied exercises according to the baseline status and the motor activity, which is being facilitated or stimulated. From the activities in bed the following are being applied: positioning, use of proprioceptive neuromuscular facilitation (PNF) techniques to facilitate breathing and prolongation the exhale phase, use of sensory training to treat the superficial and deep sensitivity of upper and lower limbs, training to recognize the body parts, and orientation for left and right, self-assisted movements, learning and training transfer in bed, manual facilitation and stimulation of diaphragmatic and chest breathing [13], training in standing up from a sitting, special attention on achieving symmetry of the body, transferring the weight with and without support of the upper limbs, gradual progression from assisted standing to independent standing and walking.

Results

Values are reported as mean \pm SD. A nonparametric analyze was used to test differences the Wilcoxon test for paired samples. There are significant differences for all parameters between start and end values. No significant differences were found between diaphragmatic movement affected and unaffected, except both hemidiaphragm spontaneous breathing posttraining values. The results from studies conducted twice have been presented – before starting the physical therapy program and at the end of the program. Patient's respiratory function and results of ultrasonography are shown in Table 1.

Table 1: Findings of lung function.

	Baseline	Posttraining
FVC (L)	1.86 ± 0.57	1.98 ± 0.51
FEV ₁ (L)	1.12 ± 0.43	1.26 ± 0.46
PEF (L/min)	123.8 ± 95.6	147.94 ± 107.7
IC (ml)	1142.9 ± 574	1442.9 ± 589
AMHAS (cm)	1.4 ± 0.35	1.6 ± 0.33
AMHNS (cm)	1.65 ± 0.32	1.98 ± 0.24
AMHAD (cm)	2.1 ± 0.74	2.43 ± 0.79
AMHND (cm)	2.6 ± 0.46	2.97 ± 0.45

Values are presented as mean ± standard deviation; FVC – forced vital capacity; FEV₁ – forced expiratory volume at one second; PEF – peak expiratory flow, IC – inspiratory capacity; AMHAS (cm) – amplitude of hemidiaphragm movement affected side spontaneous breathing; AMHNS (cm) – amplitude of hemidiaphragm movement unaffected side spontaneous breathing; AMHAD (cm) – amplitude of hemidiaphragm movement affected side deep breathing; AMHND (cm) – amplitude of hemidiaphragm movement unaffected side deep breathing.

The initial mean value of FVC is 1,86 ± 0,57 and at discharge an improvement is observed. The mean value of FEV₁ and PEF l/m are with the same tendency – 1.12 to 1.26 and 123.8 to 147.9. Inspiratory capacity is important indicator for restrictive respiratory dysfunction. There is a mean improvement of 300 ml. At start small amplitude of hemidiaphragm movement of the affected side relative to the unaffected side during spontaneous and deep breathing are reported. At the end of the program an improvement of mobility is observed in both sides, but the dominance of the unaffected side is still persisting.

Discussion

The FVC is considered as an integral indicator of the physical capacity and in particular – of the functional condition of the respiratory system [13] and in a restrictive type of respiratory disorder a decrease in value is observed. A restrictive type of respiratory disorder in subacute and chronic period is reported in several studies [14, 15]. Probably lower values in our study are due to the impaired mechanics of breathing as a result of the cerebral vascular accident [16]. The changes in FVC are likely to result of improved inspiration after training. Other authors [14, 15, 17] also report an improvement in the spirometric indicators in stroke patients after conducting a targeted workout with an incentive breathing device. Their studies were held in a subacute and chronic period with duration of 4 to 8 weeks. PEF is the peak volume rate of exhaled air during the first 100-200 milliseconds in forced exhaling and is an indicator depending on the extent of effort used to exhale. Good evidence exist that respiratory muscle function is significantly impaired after stroke because of decreased corticorespiratory outflow from damaged cortex and this result in a week cough with decreased ability to clear airways and increased risk of chest infection [16, 18]. The positive changes in these values would have a positive impact on the effectiveness of cough and reducing the risk of respiratory infection. We did not find studies for potential to influence PEF in clinical settings in acute period. In present study there is an increase of speed at discharge from the clinic with 24.14 L/m.

Inspiratory training involves the training of the

specific muscles including diaphragmatic and intercostal muscles. Biofeedback inspiratory training devices are used for improving pulmonary function and providing feedback about respiratory training to patients with stroke and neurological condition [14, 17, 19, 20]. The inspiratory capacity data in this study showed improvement for 10 days period with mean 300 ml. The greater IC value is result of improved inspiration.

Specific for all applied assessment of pulmonary function is that they are voluntary and depend from patient's ability (or willing) to activate breathing. Breathing can be activated volitionally through corticospinal pathways or automatically through bulbospinal pathways. Deep breathing is under control of the corticospinal pathways. Because of the complexity of diaphragmatic motor control, the effect of stroke and physical therapy strategies on diaphragmatic motion is controversial. Impaired respiratory function may be a consequence of weakness or/and postural trunk dysfunction [20, 21]. Changes in diaphragmatic movement – higher positioning of the diaphragm and decreased excursion of the paretic side during deep breathing are reported in several studies [11, 22]. Jung K et al., [22] report restrictive pulmonary dysfunction and unilateral reduction in motion of the diaphragm during volitional breathing. At present study smaller amplitude of hemidiaphragm movement of the affected side relative to the unaffected side during spontaneous and deep breathing are reported. But at the end of the program enhance of the diaphragmatic movement is marked. The mechanism of improving respiratory muscles function of the central drive (including feedback strategies) may be beneficial for stroke patients to improve muscle function and cough.

However, we need to underline the small number of patients due to including criteria. Despite the small number of patients, based on the results obtained, we believe that an early targeted impact on respiratory disorders in patients with ischemic cerebral stroke is applicable.

The beneficial impact of the results from the functional respiratory study during the relatively short hospital stay is probably due to the effect of training and improvement of the motor control of respiratory muscles. When using the device a visual stimulation is involved and there is an adjustment feedback during inhaling. Thus, an early inclusion of main principles of motor training is possible.

The conducted study and the results allow us to draw the following conclusions: The early application of an incentive breathing device for voluntary respiratory training is feasible in patients with ischemic cerebral stroke in clinical setting and has a positive effect on the respiratory function.

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