ORIGINAL ARTICLE

Comparison of respiratory muscle strength between elderly subjects after a stroke

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ABSTRACT

The decrease in elastic recoil of the lungs and chest cavity compliance is a major change in the respiratory system with advancing age, when these changes are associated with clinical manifestations of under lying cerebral vascular accident (stroke), respiratory muscle strength of the elderly may be seriously affected, therefore it is necessary to investigate the conditions of respiratory muscle strength in older hemiparetic patients in both the acute and chronic phases. **Objective:** To compare respiratory muscle strength in elderly hemiparetic patients in both the acute and chronic phases after stroke, evaluated by the values of maximal respiratory pressures, so that the rehabilitation of these individuals will be more targeted. **Method:** Twenty-nine hemiparetic individuals were evaluated-seventeen in acute and twelve in chronic phases, the values of maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) being measured by means of a manometer. **Results:** There was no difference between acute and chronic patients, however, measurements of MIP and MEP after the stroke showed statistically significant decreases when compared with predicted values. **Conclusion:** There was no difference in respiratory muscle strength between the acute and chronic phases, however, the fact that the MIP and MEP were also reduced in all subjects, suggests similar weakness in the respiratory musculature in both phases after stroke, and this condition can be worsened when coupled with the aging process. It is suggested that a program include muscle training for these individuals to have better rehabilitation after their strokes.

Keywords: Stroke, Sarcopenia, Vital Capacity, Aged

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Received on Feb 22, 2013.
Accepted on May 20, 2013.

DOI: 10.5935/0104-7795.20130004

INTRODUCTION

Sarcopenia, the atrophy of the skeletal musculature that brings a loss of strength and power, is reported in the literature as a fact directly related to age, being generally prevalent in an aging demographic and reaching not only the peripheral musculature, but also the respiratory.[1] In addition to muscular weakness, Kim & Sapienza[1] report that the diminution of pulmonary elastic recoil and compliance of the thoracic cavity are two of the main respiratory changes that come with advancing age.

When these alterations are combined with the clinical manifestations underlying a stroke (CVA), the respiratory muscle strength of the elderly can be seriously affected, because motor skills alterations in one hemibody, aside from fostering impairments in someone's Daily Life Activities (DLAs) will alter the respiratory biomechanics by compromising the complex interactions of the inspiratory and expiratory muscles of the thorax and abdomen,[2,3] which hampers pulmonary function and increases the risk of contracting lung infections due to weakened expiratory muscles and an inefficient cough.[4,5]

In adults with chronic hemiparesis, the alterations in respiratory muscle strength are described based on various methodologies, such as with Teixeira-Salmela et al.[6] who report decreased respiratory muscle strength and thoracic-abdominal mobility among chronic hemiparetics as compared with a control group. More recently, Meneghetti et al.[7] found reduced respiratory pressure values among chronic hemiparetics as compared with what was predicted for a Brazilian population. Similar results were reported among acute hemiparetics, described as reduced electromyographic activity of the intercostal and diaphragm muscles during voluntary inspiration after an acute stroke.[8,9]

Among the elderly, alterations of the respiratory muscle function are considered of great importance in the decline of pulmonary function and are described as limiting and able to compromise their functional reserve, making them symptomatic and limiting their tolerance to exercise.[10,11]

In view of this, it is clear that there is evidence of respiratory impairment among hemiparetics, however, there is no reference of how this deficit effects the elderly with stroke-induced hemiparesis; there are also no reports as of yet on any differences in muscle strength impairment between the acute and chronic phases following a stroke.

OBJECTIVE

The goal was to compare the respiratory muscle strength of acute and chronic hemiparetics, evaluated by means of the maximum respiratory pressure readings, so that the rehabilitation of these individuals might be better guided.

METHOD

Case Study

This was a cross-sectional study that used a convenience sample of individuals recruited from the Physiotherapy Department of the *Universidade Nove de Julho* (*Nove de Julho Hospital*) and from the *Complexo Hospitalar Mandaqui* (Mandaqui Hospital Complex). There were initially 49 screened individuals, 25 from the hospital and 24 outpatient and the inclusion criteria were to have stroke-induced hemiparesis, to have full cognitive function, to have been evaluated by a mini-exam of their mental state (mini-mental), and to be aged 60 or more. Excluded from the study were individuals on respirators or any other ventilatory resources, those who used a nasogastric tube, or who were taking oral corticoids, central nervous system depressants, barbiturates, or muscle relaxants. To fit into the chronic stroke group, the individuals should have had their stroke episode at least six months before the study. Encephalic lesions less than three months old were considered acute.[12]

All the participants signed the free informed consent form and were informed of their possibility of withdrawing from the research at any phase with no penalty. This study was analyzed and approved by the Committee on Ethics In Research at the Nove de Julho University (protocol nº 248018/09).

Procedures

Respiratory muscle strength was evaluated in terms of the maximum inspiratory pressure (IPmax) and maximum expiratory pressure (EPmax), as in the Black & Hyatt[13] method, by means of a Gerar® brand analog manovacuometer (on a scale from 0 to 300 cmH_2O). Plastic mouthpieces were adapted and connected to the orifice in the machine which was about 2mm in diameter. This has the function of impeding the pressure exerted by the mouth muscles from interfering in the specified pressure readings. The reference readings for maximum respiratory pressures were based on values predicted by age and gender, as described by Neder, et al.[14]

The measurements were all collected by the same examiner using the same verbal trigger. Evaluations were made with the subjects seated and with their nostrils blocked by a nasal clip. The patients did the IPmax measurement from the functional residual capacity until the maximum inspiratory capacity. The EPmax was done from the maximum inspiratory capacity until the functional residual capacity. Each volunteer made between three and five efforts of maximum inspiration and expiration, and sustained it for at least two seconds with readings close to each other (≤ 10%); the highest reading was considered for this study.[15,16]

Statistical analysis

Descriptive statistics were used to characterize the sample. The Shapiro-Wilk normality test was used to verify the distribution of data. All variables were summarized by average and standard deviation. For non-paired variables, the Student *t*-test was used for comparison between the chronic group and the acute group and for comparisons between muscle strength obtained and predicted.[14]

RESULTS

After triaging the original 49 individuals, the illegible population came to 29 volunteers, hemiparetic as a result of their strokes, who met the established inclusion criteria, of which 17 were in the acute phase (< 6 months post-stroke) and 12 in the chronic phase (> 6 months past-stroke); eight hospitalized individuals were excluded from the study: five were at a reduced level of consciousness, two were tracheostomized and had nasogastric tubes, and twelve outpatients were excluded for being unable to close their mouths. Table 1 shows the clinical-demographic characterizations of the groups studied.

Concerning respiratory muscle strength, patients in the acute phase were seen to get higher readings on IPmax than chronic patients, however no significant statistical difference was observed between the groups ($p = 0.57$).

With EPmax there was also no significant statistical difference ($p = 0.64$), although the acute hemiparetics showed lower values than those in the chronic phase.

Table 1. Demographic characterizations of the volunteers in the study

Variable	Acute Stroke (n = 17)	Chronic Stroke (n = 12)
Gender (M/F)	8/9	10/2
Age (years)	74 ± 8	67 ± 6
Time of stroke (months)	2 ± 1	23 ± 15
IPmax highest obtained	49.2 ± 26.81	40.83 ± 26.38
IPmax (% predicted)	61.17	43.87
EPmax highest obtained	71.0 ± 33.3	68.5 ± 30.6
EPmax (% predicted)	75.08	66.67

Data is expressed as average and standard deviation (SD) or percentage. M: Male; F: Female; IPmax: Maximum Inspiratory Pressure; EPmax: Maximum Expiratory Pressure

As described by Neder et al.[14] the comparisons between actual readings of IPmax and EPmax and predictions based on age and gender were analyzed. This comparison is better elucidated in Table 2, in which all the individuals with stroke can be seen to have less respiratory muscle strength than was predicted.

DISCUSSION

The results of this study can be seen to indicate an impairment in respiratory muscle strength dating from the initial phase after the stroke, and it is noteworthy that both groups showed reductions in IPmax and EPmax readings as compared to readings predicted for Brazilian populations (Table 2). The broad range of IPmax and EPmax readings observed in both groups suggests varying degrees of recovery among the individuals. These findings concur with studies carried out separately within this same population.[6-9]

The neurological deficits stemming from a stroke provoke muscle weakness in the entire affected hemibody, including the respiratory musculature. The first study developed that reported on this impairment was by Smith,[16] who evaluated the thoracic radiography of acute and chronic hemiparetic individuals and observed an elevation of the diaphragm of the affected hemibody. Around three decades later, Cohen et al.[17] confirmed the reduction in the diaphragmatic excursion while evaluating the voluntary and spontaneous respiration among hemiparetics by means of ultrasonography. Flucks[18] and Korczyn[19] observed a reduction in thoracic mobility in 57 hemiparetic patients during voluntary respiration.

In one study made by Teixeira-Salmela et al.[6] they observed that chronic hemiparetic individuals showed a diminution of IPmax and EPmax when compared to a control group. Meneghetti et al.[7] also found similar results, reporting diminution of respiratory muscle strength and their readings were lower than what was predicted for the Brazilian population.

The respiratory muscle weakness of the analyzed volunteers could be explained by their age, seeing that the literature confirms the progressive reduction in IPmax and EPmax in accordance with their increasing age, finding a negative correlation between age and respiratory pressures, as much in males as in females.[20,21] These reductions with age in the IPmax and EPmax readings may be related to the physiological alterations that come with senescence, such as changes in the lung tissue and the chest cavity, which entail a reduction in the mass and efficiency of the respiratory musculature.[22]

However, it must be considered that the IPmax of stroke victims in the acute phase is lower than that of those in the chronic phase, even if they are older. This could have occurred because of the interference from the spasticity of the paradoxical movement of the upper thorax.[23]

Even though the acute phase hemiparetics had higher values of IPmax than the chronic patients, their respiratory muscle strength was also reduced. These results corroborate the findings of the study by Lanini et al.[23] who used plethysmography to prove that there was a reduction of movement in the affected hemithorax during voluntary hyperventilation, and also observed lower respiratory pressures among acute hemiparetics than among the control group.

It is noteworthy that there is evidence of the diminution of respiratory muscular activity starting with the acute post-stroke phase,[8,9] which explains the significant reduction in maximum respiratory pressure readings found in this study.

More recently, Jandt et al.[24] found no correlation between trunk control and inspiratory muscle strength; this correlation was only between EPmax and the expiratory flow with trunk control. In addition we infer that not only flaccid tone interfered with respiratory mechanics, but also that hypertonia and persistent muscle weakness in the trunk muscles exert a negative influence on expiratory muscle strength.

Considering the reduction in respiratory muscle strength of the patients evaluated, and that this is a strong predictor of post-stroke morbidity/mortality,[25] greater interested is recommended in re-establishing the respiratory function of these patients. There are studies[26,27] that demonstrate that respiratory muscle training promoted improvements in IPmax, a greater ability to perform exercises, in addition to an improved quality of life in the acute and chronic phases after a stroke, thus showing that this conduct must be adopted for better functional recovery for these individuals.

Although the results of this study may aid in the conduct of rehabilitation and favor the guidance of more suitable treatment strategies, we must point out that this study was composed of a convenience sample and, for this reason, it did not include enough individuals as was indicated by the sampling calculation. For this reason we suggest that other studies be carried out, but with larger samples and that evaluate other variables of pulmonary function in addition to respiratory muscle strength, such as forced expiratory s (FEV1) in the first second, forced vital capacity (FVC), and peak expiratory flow.

Table 2. Comparison of the readings for maximum inspiratory pressure (IPmax) and maximum expiratory pressure (EPmax) obtained and predicted in acute and chronic stroke

Variable	Highest reading obtained	Predicted reading	*p* value
IPmax acute stroke	49.2 ± 26.8	89.6 ± 12.4	0.002*
IPmax chronic stroke	40.83 ± 26.3	98.1 ± 12.2	0.001*
EPmax acute stroke	71.0 ± 33.3	94.1 ± 18.6	0.02*
EPmax chronic stroke	68.5 ± 30.6	105.2 ± 17.21	0.002*

IPmax: Maximum Inspiratory Pressure; EPmax: Maximum Expiratory Pressure

We also point out the need for longitudinal studies that track the patients from the acute phase into the chronic phase so as to determine the cause and effect relationships among the variables studied, since transversal studies such as the one done here do not yield causal relationships.

CONCLUSION

In the population studied there was no difference in respiratory muscle strength between the acute phase and the chronic phase after stroke, however a diminution of IPmax as well as EPmax was observed among all the individuals evaluated. Therefore, we can infer that the inspiratory musculature is affected in a similar way in both post-stroke phases, and this situation can be aggravated by the process of senescence.

In addition, we suggest that a respiratory muscle training program be instituted for these individuals for better post-stroke rehabilitation.

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