ORIGINAL RESEARCH

Respiratory Muscle Strength in Chronic Stroke Survivors and Its Relation With the 6-Minute Walk Test

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Abstract

Objectives: To compare respiratory muscle strength in stroke survivors (SS) with that in a control group (CG) of healthy people matched by age and sex, as well as to investigate any relation between respiratory muscle strength and the distance walked during the 6-minute walk test (6MWT).

Design: Cross-sectional study.

Setting: This study comprised patients from a private neurological rehabilitation center and a public association for patients with acquired brain injury.

Participants: Chronic SS with a diagnosis of hemiplegia/hemiparesis who were able to walk (n=30) and healthy individuals matched by sex and age (n=30) (N=60).

Interventions: Not applicable.

Main Outcome Measures: Respiratory muscle strength was assessed using maximal expiratory pressure (MEP) and maximal inspiratory pressure (MIP) with a pressure transducer and a diver nozzle. The distance walked during the 6MWT was also registered for both groups. The motricity index and the Scale Impact of Stroke version 16.0 were also measured in SS.

Results: The Student t test revealed significantly lower values of MIP and MEP in SS than in the CG (MEP, 95.93±43.12cmH$_2$O in SS vs 158.43±41.6cmH$_2$O in the CG; MIP, 58.7±24.67cmH$_2$O in SS vs 105.7±23.14cmH$_2$O in the CG; $P<.001$). Moreover, these findings were clinically relevant because both MIP and MEP in SS were <60% of the predicted values. A positive correlation between the 6MWT and MIP was found using the Pearson coefficient ($r=.43$; $P<.018$).

Conclusions: Respiratory muscle weakness should be considered in a holistic approach to stroke rehabilitation.

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Stroke is a major cause of disability in adults worldwide and is a key social health concern in Spain, where an estimated annual incidence is 252 per 100,000 people.[1,2] Some respiratory problems have been identified immediately after the stroke during the acute and subacute period, such as sleep disorders,[3] altered ventilatory patterns,[4,5] and risk of aspiration.[6] However, neurological rehabilitation approaches to chronic stroke survivors (SS) rarely take into account assessment and treatment of respiratory muscles. A literature review[7] carried out in 2011 showed that patients with chronic hemiplegia/hemiparesis after a stroke have limitations in their static and dynamic volumes and present respiratory muscle alterations and concluded that these responses should be considered during patient rehabilitation. Few studies[8-11] published in the past 10 years have assessed respiratory muscle strength in patients with stroke, gauging maximal expiratory pressure (MEP) and maximal inspiratory pressure (MIP). A systematic review[12] published in 2013 concluded that SS have respiratory muscle weakness, which could be correlated with a higher risk of chest infections in that population. A significant decrease in peak cough flow has also been observed in subacute[13] and chronic[14] SS compared with a control group (CG) of healthy individuals, which has been related to a lack of respiratory muscle strength and coordination.[15] Respiratory muscle strength has been poorly studied

in chronic SS, and there are several differences in the methodology and protocols for its measurement. A decrease in MEP in patients with hemiplegia has been related to a lack of trunk control,[16] whereas a lower value of MIP has been correlated with a decrease in gait speed.[17]

The primary aim of this study was to compare respiratory muscle strength in SS with that in a CG of healthy people matched by age and sex. The secondary aim was to investigate any relation between respiratory muscle strength and the distance walked during the 6-minute walk test (6MWT).

Methods

Study design

Data in this article are a subset of baseline data from a cross-sectional study of pulmonary function in patients with chronic hemiplegia/hemiparesis after a stroke as compared with a CG of healthy people matched by age and sex.

Participants and setting

The present study was conducted with patients from a private neurological rehabilitation center and a public association for patients with acquired brain injury, both located in Galicia, Spain. The recruitment was carried out from January 15, 2012 to October 15, 2014. Thirty-three patients with chronic hemiplegia/hemiparesis were recruited from a potential sample of 146 SS and filtered using the following criteria in accordance with the principal study.

Inclusion criteria

We included individuals if they had a diagnosis of hemiplegia/hemiparesis and ≥6 months have passed since the onset of the stroke; were aged >18 years; were receiving neurological rehabilitation treatment; were able to walk with or without assistance (assistive device, orthotic device, and/or physical aid from another person); were able to understand instructions for several tests; demonstrated a willingness to participate in the study.

Exclusion criteria

We excluded individuals who were current or ex-smokers for ≥1 year; had a diagnosis of pulmonary disease; had a diagnosis of severe cardiovascular disease; had any other neurological impairment; had experienced thoracic or abdominal surgery in the previous 3 months; had severe facial paralysis; had severe kyphoscoliosis; and were receiving specific cardiovascular training or respiratory physiotherapy.

Thirty-three individuals in the CG were selected from the staff of the University of A Coruña and from the users of a local residential home for the elderly by using the same criteria described for SS. The individuals in the CG were matched by age and sex with SS because those variables can influence the results of maximal respiratory pressures.[18]

List of abbreviations:

6MWT	6-minute walk test
CG	control group
MEP	maximal expiratory pressure
MIP	maximal inspiratory pressure
SS	stroke survivors

This project was approved by the Clinical Research Ethics Committee of Galicia. All individuals gave their written consent to participate.

Procedure

Participant assessments were carried out in the Faculty of Physiotherapy, University of A Coruña. A specially trained physiotherapist conducted all measurements in 2 sessions.

First visit

All participants underwent a standardized interview about their demographic and clinical characteristics and rehabilitation procedure details. Anthropometric and vital signs (heart rate, breath rate, oxygen saturation level, blood pressure) were also noted. Two 6MWTs were conducted in both groups in an indoor corridor (30m long, with each meter marked) that was seldom traveled, in line with the international statements.[19] Before starting, clear indications for the test were given to the participants. The principal instruction was to "walk as fast as you can without running." Standardized verbal encouragement, described for the validated Spanish version,[20] was given. The participants in the SS group were allowed to use their customary assistive/orthotic devices. When physical or supervision aid from another person was needed, we trained a companion (normally a relative) to walk with the participant without influencing his/her gait speed. Individuals had to rest for ≥30 minutes before starting the second test. Distance (in meters) and speed gait (in meters per second) were calculated.

To characterize the sample, additional tests were performed. Motor function in patients with stroke was assessed through the motricity index[21] using the protocol described by Collin et al.[22] We used the Scale Impact of Stroke version 16.0[23] to assess the consequences of the stroke. The Scale Impact of Stroke version 16.0 has been validated for the Spanish population.[24]

Second visit

MEP and MIP were measured, in line with the international statements,[25] using a pressure transducer (model 511-8D0-MU1[a]) with an operating interval of ±300cmH$_2$O and a precision of 3% connected to a spirometer Datospir 120C.[a] Equipment calibration was performed according to the international standards.[25] All measurements were taken in a sitting position with a rubber diver nozzle (scuba mouthpiece) and a nose clip, with participants asked to sustain pressures for 3 to 5 seconds.[26] The pressure transducer calculated the maximal peak pressure generated after the first second (the first second is discounted because of inertia). Participants were asked to hold their cheeks rigid with their hands to avoid leaks and to minimize buccinator muscle contributions during the maneuvers. In the case of a subject with moderate facial paralysis, as described in the literature,[27] an assistant physiotherapist held the participant's lips around the mouthpiece to ensure a perfect seal between lips and the nozzle. When an SS was unable to adequately move an upper limb, an assistant would manually support the patient's cheeks. We performed a maximum of 10 repetitions to measure MEP and MIP values, with a minimum of 6 acceptable maneuvers, 3 of them with variability <5% (repeatability criteria).[26] We chose the highest reading of the 3 reproducible maneuvers. The participants had to rest for 1 minute between each repetition of MEP and 5 minutes before starting the MIP repetitions. The Morales' predictive equations,[28] created from a healthy sample of Spanish people, were used in this study.