Evaluation of Respiratory Muscle Strength in the Acute Phase of Stroke: The Role of Aging and Anthropometric Variables

Gustavo José Luvizutto, PhD,* Maria Regina Lopes dos Santos, PT,* Lorena Cristina Alvarez Sartor, PT,* Josiela Cristina da Silva Rodrigues, PT,* Rafael Dalle Molle da Costa, PT,* Gabriel Pereira Braga, PhD,† Letícia Cláudia de Oliveira Antunes, PhD,* Juli Thomaz Souza, MsC,‡ Hélio Rubens de Carvalho Nunes, MsC,‡ Silméia Garcia Zanati Bazan, PhD,‡ and Rodrigo Bazan, PhD†

Background: During hospitalization, stroke patients are bedridden due to neurologic impairment, leading to loss of muscle mass, weakness, and functional limitation. There have been few studies examining respiratory muscle strength (RMS) in the acute phase of stroke. *Objective:* This study aimed to evaluate the RMS of patients with acute stroke compared with predicted values and to relate this to anthropometric variables, risk factors, and neurologic severity. *Methods:* This is a cross-sectional study in the acute phase of stroke. After admission, RMS was evaluated by maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP); anthropometric data were collected; and neurologic severity was evaluated by the National Institutes of Health Stroke Scale. The analysis of MIP and MEP with predicted values was performed by chi-square test, and the relationship between anthropometric variables, risk factors, and neurologic severity was determined through multiple linear regression followed by residue analysis by the Shapiro-Wilk test; $P < .05$ was considered statistically significant. *Results:* In the 32 patients studied, MIP and MEP were reduced when compared with the predicted values. MIP declined significantly by 4.39 points for each 1 kg/m^2 increase in body mass index (BMI), and MEP declined significantly by an average of 3.89 points for each 1 kg/m^2 increase in BMI. There was no statistically significant relationship between MIP or MEP and risk factors, and between MIP or MIP and neurologic severity in acute phase of stroke. *Conclusion:* There is a reduction of RMS in the acute phase

From the *Department of Applied Physical Therapy - Institute of Health Sciences, Federal University of Triângulo Mineiro (UFTM), Uberaba, MG, Brazil; †Department of Neurology, Psychology and Psychiatry, Botucatu Medical School (UNESP), Botucatu, SP, Brazil; and ‡Department of Internal Medicine, Botucatu Medical School (UNESP), Botucatu, SP, Brazil.

Received February 4, 2017; revision received April 29, 2017; accepted May 12, 2017.

Author contributions: M.R.L.S., J.C.R.S., L.C.A.S., and S.G.Z.B. were responsible for project inception. J.C.S.R., M.R.L.S., G.J.L., R.D.M.C., L.C.O.A., R.B., and S.G.Z.B. were involved in study design, protocol preparation, drafting the manuscript, and acquisition of funding. H.R.C.N. conceived the statistical analyses and sample size. M.R.L.S. has been involved in data collection. All authors have reviewed and approved the final manuscript.

Ethics approval and consent to participate: This study was approved by a Committee for Ethics in Research involving human subjects from Botucatu Medical School. On inclusion, all subjects were asked for their written informed consent to participate in accordance with the Declaration of Helsinki II.

Address correspondence to Gustavo José Luvizutto, PhD, Departamento de Fisioterapia Aplicada, Universidade Federal do Triângulo Mineiro, Casa Terra. Rua Capitão Domingos, 309. Abadia, Uberaba, MG, Brazil. E-mail: gluvizutto@gmail.com.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2017.05.014

of stroke, and RMS was lower in individuals with increased age and BMI. **Key Words:** Stroke—respiratory muscle strength—MIP—MEP—obesity—aging.

Introduction

Stroke affects approximately 16.9 million people worldwide, generating about 100,000 people with functional disability per year.[1] Stroke is the main cause of mortality and chronic disability in adults in Latin America and Brazil, with around 200,000 cases annually.[2-4]

Stroke is defined as neuronal death due to prolonged ischemia, which is caused by obstruction to cerebral blood flow or intracranial hemorrhage.[5,6] About 90% of patients present hemiparesis, with decreased strength and motor control after stroke, compromising daily life activities, mobility, and locomotion.[7,8]

During hospitalization, stroke patients become bedridden due to neurologic impairment, leading to loss of muscle mass, weakness, and functional limitation.[9] The main complications during hospitalization due to immobility are reduction of chest expansion and respiratory complications, with pneumonia being the most common in this population.[10]

Respiratory complications may also occur due to changes in respiratory patterns, as well as from weakness of respiratory muscles. Respiratory muscle strength (RMS) is one of the most important factors in maintaining intact lung function.[11] Weakened muscles result in decreased diaphragmatic movement and chest expansion, thus increasing mechanical resistance to respiration, and decreased ventilation and cough effectiveness, thus leading to difficulty in eliminating secretions, which significantly increases the risk of lung infections.[12] In detailed physiological studies of respiratory muscle function, it was found that parameters of RMS (maximum inspiratory and expiratory mouth pressures, sniff pressure) in stroke subjects were reduced by one third to one half, and can be of importance in achieving physical capacity a posteriori and the ability to perform daily life activities in the long term.[13,14]

There have been few studies that examine RMS in the acute phase of stroke, and the present study has as an innovation the description and the relationship of sociodemographic factors and their impact on RMS in the acute phase of stroke, so that health professionals are attentive in the conduct of clinical care and to the patient with potential risk of respiratory complications. We hypothesized that low values of inspiratory and expiratory pressure decrease the efficiency of ventilatory mechanics, especially in individuals with aging and higher comorbidities in acute phase of stroke; therefore, the aim of this study was to evaluate the RMS of patients with acute stroke compared with the predicted values and to relate this to anthropometric variables and severity of the neurologic condition.

Methods

Study Design, Setting, and Participants

This is a cross-sectional study of patients admitted to the stroke unit of the Botucatu Medical School from July until December 2016. We evaluated individuals with a diagnosis of ischemic stroke confirmed by neuroimaging (computed tomography or magnetic resonance), aged over 18 years, and who scored 0 in item 1a of the National Institutes of Health Stroke Scale (NIHSS). Patients with hemorrhagic stroke, previous complaints of dysphagia, prior stroke with a score of more than 2 on the modified Rankin scale, pre-existing dementia, clinical instability, comatose state, acute and chronic pulmonary diseases, and other neurologic diseases were excluded. After signing the informed consent, RMS and both demographic and anthropometric data, in addition to the NIHSS scale, were evaluated in the stroke unit.

Variables

Exposures

The independent variable RMS was evaluated using the Comercial Médica (São Paulo, Brazil) manovacuometer, with maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) being evaluated until 48 hours after admission.

Measurements

(A) Maximum inspiratory pressure (MIP): the patient was positioned at 45° on the bed and was requested to perform maximum expiration up to the residual volume level. Subsequently, maximal inspiratory effort was requested, and held for about 1 second. The reading of the measurement value was checked directly on the manovacuometer display. The maneuvers were repeated 3 times, at intervals of about 1 minute, with the highest MIP value used in the analysis.

(B) Maximum expiratory pressure (MEP): the patient was positioned at 45° on the bed and was requested to perform maximum inspiratory effort until total lung capacity was reached. A maximal expiratory effort was then requested, and maintained for about 1 second. The reading of the measurement value was checked directly on the manovacuometer display. The maneuvers were repeat-