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Respiratory Impairment in Stroke Patients with Bilateral Hemisphere Involvement – An Institutional Experience

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Abstract

Background: *Stroke is considered one of the major causes of impairments in activities of daily living. Respiratory dysfunction in stroke patients, especially those with bilateral hemisphere involvement, is often overlooked despite its critical role in recovery. This study focuses on the prevalence and impact of respiratory impairment in cerebrovascular accident (CVA) patients with bilateral hemispheric involvement.* ***Objectives:*** *The objective of this study was to determine the prevalence of respiratory impairment in stroke patients with bilateral hemisphere involvement. Materials and* ***Methods:*** *A cross-sectional study was conducted on 37 stroke patients with bilateral CVA admitted to the Jorhat Medical College & Hospital. Variables, such as Peak Expiratory Flow Rate (PEFR), inspiratory muscle strength (IMS), expiratory muscle strength (EMS), and the rate of dyspnea (RDOS), were assessed. Statistical analysis was conducted using SPSS software, and chi-square tests and Spearman's correlation were applied to evaluate relationships between variables. Regression analysis was used to model the relationship between PEFR and RDOS.* ***Results:*** *Statistical analysis revealed no significant associations between sex, age, or type of CVA and respiratory function ($p > 0.05$). However, a strong negative correlation ($r = -0.885$) was found between PEFR and RDOS, indicating that lower respiratory function was associated with increased dyspnea. Regression analysis provided the equation $Y = 6.208 - 0.013X$ for predicting RDOS from PEFR.* ***Conclusion:*** *The results suggest that respiratory impairment is significant in stroke patients with bilateral hemisphere involvement. Lower PEFR was strongly associated with higher dyspnea rates, reinforcing the need for respiratory-focused interventions in stroke rehabilitation.*

Keywords: Bilateral hemisphere, cerebrovascular accident, dyspnea, PEFR, rehabilitation, respiratory impairment, stroke

INTRODUCTION

A cerebrovascular accident (CVA), or stroke, is a clinically recognized syndrome marked by sudden, localized neurological deficits resulting from vascular damage in the central nervous system. It occurs when blood vessels in the brain become blocked or ruptured, causing a rapid loss of brain cells due to insufficient oxygen supply [1, 2]. It ranks as the second most common cause of death worldwide and is the primary cause of disability, impacting approximately 13.7 million individuals globally and resulting in about 5.5 million deaths annually.

Although many stroke patients experience considerable motor impairments, respiratory dysfunction is frequently neglected, even though it plays a vital role in rehabilitation and recovery. Studies show that stroke can impact respiratory function by disrupting the central breathing rhythm, hindering communication between the brain and

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respiratory muscles, or causing weakness in the bulbar region [3, 4]. Notably, respiratory impairments can be associated with a higher risk of complications and mortality, particularly in those with bilateral hemisphere involvement.

This study aimed to evaluate the prevalence of respiratory impairment specifically in patients of CVA with involvement of bilateral hemisphere admitted to a tertiary care center in Jorhat, Assam. By emphasizing the importance of respiratory function, this research seeks to enhance rehabilitation strategies and patient care [5].

METHODOLOGY

This study was a cross-sectional study, and convenient sampling was adopted. Ethical clearance was obtained from the institutional ethical committee, and informed consent was secured from each participant after comprehensive information about the study was provided. A total of 37 participants diagnosed with cerebrovascular accidents (CVA) with bilateral hemispheric involvement were included in the study. The inclusion criteria were: (i) Diagnosis of CVA with bilateral hemispheric involvement confirmed by CT or MRI report, (ii) Age between 35 and 75 years, (iii) Both genders, and (iv) Glasgow Coma Scale score of more than 8 indicating sufficient responsiveness. Exclusion criteria included: (i) Presence of other respiratory or cardiac complications, (ii) Recent fractures of ribs or skull, and (iii) Patients unwilling to participate.

On the day of evaluation, each participant underwent a comprehensive assessment that took approximately 15–20 minutes (Figure 1). The assessments conducted were as follows:

- *Inspiratory Muscle Strength:* Was assessed using the Medical Research Council (MRC) scale. Manual muscle testing was performed by palpating the diaphragm and intercostal muscles while applying manual resistance against their contraction, with each participant graded from 0 (no detectable contraction) to 5 (normal strength) [5].
- *Expiratory Muscle Strength:* Was similarly assessed, focusing on the abdominal muscles and their ability to generate force during expiration. Grading included functional, slightly functional, non-functional, and null [6].
- *Measurement of Peak Expiratory Flow Rate (PEFR):* This was measured using a portable peak flow meter. Participants were instructed to sit comfortably, take a deep breath through the nose, and exhale forcefully through the mouthpiece of the device. The process was repeated three times, and the best score was recorded [7].
- *Assessment of Dyspnea:* The level of dyspnea was evaluated using the Respiratory Distress Observation Scale. Participants were monitored for several parameters: respiratory rate, heart rate, breathing patterns, accessory muscle use, flaring of nostrils, grunting sounds during expiration, restlessness, and overall appearance. Each parameter was scored from 0 to 2, with total scores indicating respiratory comfort or distress [8].

Figure 1. Tests conducted during the evaluation session.

At the conclusion of the evaluation, data were statistically analyzed using SPSS software. Statistical significance was set at $p < 0.05$. Chi-Square tests were conducted to assess relationships between various factors, and Spearman's rank correlation was used to evaluate relationships among ordinal variables. A linear regression analysis was also performed with RDOS as the dependent variable and PEFR as the independent variable.

All 37 subjects completed the study, and the results were utilized to draw conclusions regarding respiratory impairment related to bilateral hemispheric CVA.

RESULTS

Data were statistically analyzed using SPSS software. The mean age of the patient was 48.16 years (Figure 2).

Among the 37 patients 62.2% were male and 37.8% were female (Figure 3) and 81.1% were ischemic stroke and 18.9% were hemorrhagic stroke (Figure 4). The data comprised patients ranging in age from 36 to 75 years, and it included both male and female participants. Several statistical tests were conducted, starting with chi-square tests to assess relationships between variables. The chi-square test between age and sex gave a p-value of 0.068, suggesting no significant association (Table 1). Similarly, the chi-square tests between sex and type of CVA ($p = 0.242$) (Table 2) and between PEFR and type of CVA ($p = 0.240$) (Table 3) indicated no significant associations.

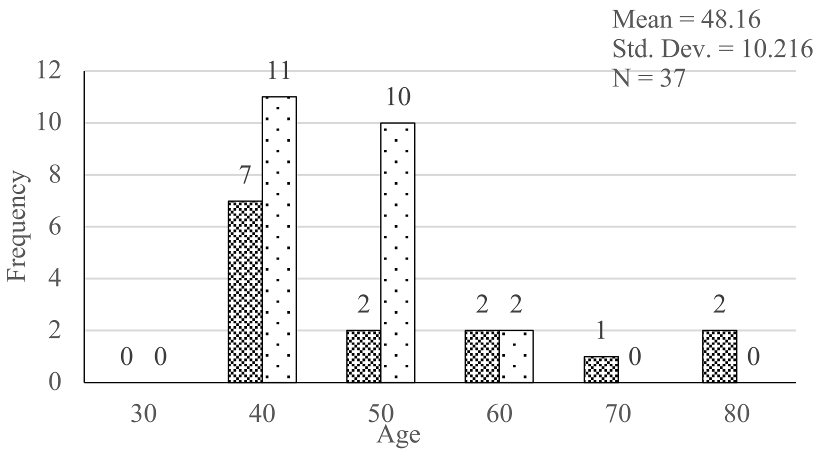

Figure 2. Age of patients.

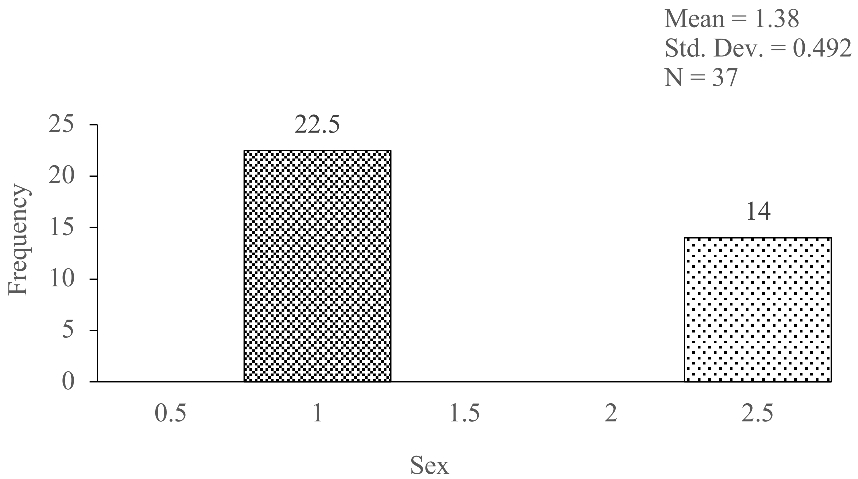

Figure 3. Sex of patients.

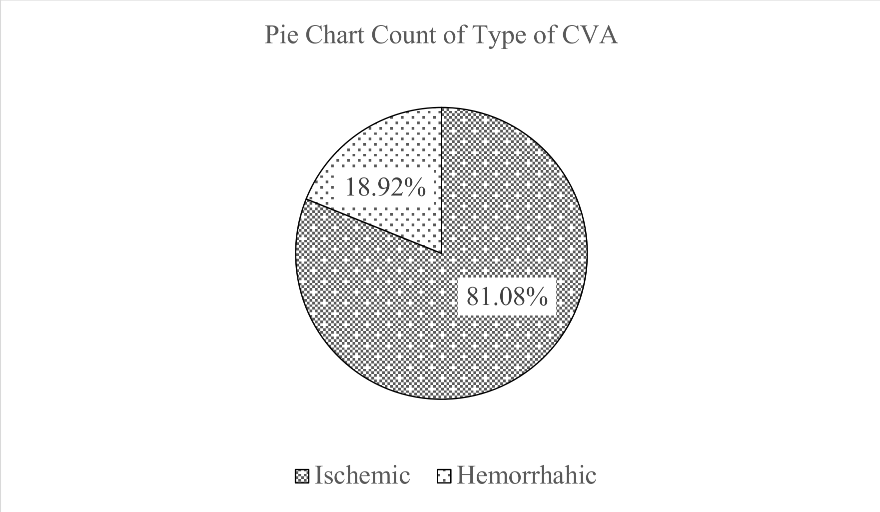

Figure 4. Type of CVA.

Table 1. Age and sex.

Chi-square tests			
	Value	**df**	**Asymptotic significance (2-sided)**
Pearson Chi-Square	27.647[a]	18	0.068
Likelihood Ratio	36.806	18	0.006
Linear-by-Linear Association	5.911	1	0.015
N of Valid Cases	37		

Note: a. 38 cells (100.0%) have expected countless than 5. The minimum expected count is 0.38.

Table 2. Sex and type of CVA.

Chi-square tests					
	Value	**df**	**Asymptotic significance (2-sided)**	**Exact sig. (2-sided)**	**Exact sig. (1-sided)**
Pearson Chi-Square	1.368[a]	1	0.242		
Continuity Correction[b]	0.543	1	0.461		
Likelihood Ratio	1.330	1	0.249		
Fisher's Exact Test				0.390	0.228
Linear-by-Linear Association	1.331	1	0.249		
N of Valid Cases	37				

Note: a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.65.
b. Computed only for a 2×2 table.

Table 3. PEFR and type of CVA.

Chi-square tests			
	Value	**df**	**Asymptotic significance (2-sided)**
Pearson Chi-Square	31.785[a]	27	0.240
Likelihood Ratio	30.889	27	0.276
Linear-by-Linear Association	0.002	1	0.962
N of Valid Cases	37		

Note: a. 56 cells (100.0%) have expected count less than 5. The minimum expected count is 0.19.

Correlation analysis was performed to evaluate the relationship between inspiratory muscle strength (IMS), expiratory muscle strength (EMS), the rate of dyspnea (RDOS), and the peak expiratory flow rate (PEFR) (Table 4). A significant correlation was found among these variables, with a strong negative correlation between PEFR and RDOS (Table 5), demonstrated by a correlation coefficient of –0.885. This suggests that as PEFR decreases, RDOS increases.

Table 4. Spearman's rank correlation to assess the relationship between the ordinal variables.

Correlations					
		Inspiratory muscle strength	**Expiratory muscle strength**	**Rate of dyspnea**	**Zones**
Inspiratory Muscle Strength	Pearson Correlation	1	0.629**	–0.683**	0.458**
	Sig. (2-tailed)		0.000	0.000	0.004
	N	37	37	37	37
Expiratory Muscle Strength	Pearson Correlation	0.629**	1	–0.926**	0.833**
	Sig. (2-tailed)	0.000		0.000	0.000
	N	37	37	37	37
Rate of Dyspnea	Pearson Correlation	–0.683**	–0.926**	1	–0.791**
	Sig. (2-tailed)	0.000	0.000		0.000
	N	37	37	37	37
Zones	Pearson Correlation	0.458**	0.833**	–0.791**	1
	Sig. (2-tailed)	0.004	0.000	0.000	
	N	37	37	37	37

Note: Correlation is significant at the 0.01 level (2-tailed).

Table 5. Correlation between PEFR and rate of dyspnea (RDOS).

Correlations			
		Peak expiratory flow rate	**Rate of dyspnea**
Peak Expiratory Flow Rate	Pearson Correlation	1	–0.885**
	Sig. (2-tailed)		0.000
	N	37	37
Rate of Dyspnea	Pearson Correlation	–0.885**	1
	Sig. (2-tailed)	0.000	
	N	37	37

Note: Correlation is significant at the 0.01 level (2-tailed).

A regression analysis further examined the relationship between PEFR and RDOS. The resulting regression equation, $Y = 6.208 - 0.013X$, where Y represents RDOS and X represents PEFR, allows for the estimation of RDOS values based on a patient's PEFR (Table 6).

Table 6. Regression analysis between PEFR and RDOS, taking RDOS as dependent variable and PEFR as independent variable.

Coefficients[a]					
	Unstandardized B	**Coefficients std. error**	**Standardized coefficients beta**	**t**	**Sig.**
(Constant)	6.208	0.220		28.228	0.000
Peak Expiratory Flow Rate	–0.013	0.001	–0.885	–11.261	0.000

Note: a Dependent variable: rate of dyspnea.

DISCUSSION

The objective of this study was to check the prevalence of respiratory impairment in patients with cerebrovascular Accident with bilateral hemispheric involvement. 37 subjects with CVA with bilateral hemispheric involvement were included in this study, among which 23 were male and 14 were female. Demographic data and all other essential data including consent forms were taken on the day of assessment. The outcome variables respiratory muscle strength, peak expiratory flow rate and rate of dyspnea were assessed on the day of assessment.

In this study the gender distribution was such that there were 62.2% male patient and 37.8% were female patients and mean age is 48.16 with standard deviation of 10.216 years.

Considering the type of stroke in this study, 81.1% of patients had ischemic stroke and 18.9% had hemorrhagic stroke. A chi-square test was conducted to test whether there is any association between sex and the type of stroke. Since the p-value was >0.05, the result did not show any significant association between sex and the specific type of stroke. Although the pathophysiology of hemorrhagic and ischemic stroke is very different from each other, sex may not be the only deciding factor because of which person exhibit different type of stroke. This result strongly supports the earlier findings of Johanna Ospel et al. who stated that although there are notable differences in risk factors and presentation between sexes, these do not imply a significant association with the type of stroke when other risk factors are considered [9].

A Spearman’s rank correlation test was conducted to see the correlation between peak expiratory flow rate, inspiratory muscle strength, expiratory muscle strength and rate of dyspnea. Since correlation is significant at 0.01 level (2-tailored), it indicates these variables are correlated with each other. This result supports the earlier findings of Kyeongbong lee et al. who stated that peak expiratory flow rate is crucial measures of pulmonary function. His study indicates that stronger respiratory Muscles particularly expiratory Muscles contribute to higher peak expiratory flow rate values [10].

In acceptance of alternative hypothesis which stated that there is a significant association between respiratory impairment in stroke patients with bilateral hemisphere involvement. This hypothesis was based on the previous findings of Abdurrahim Yildiz et al. who stated that respiratory muscle weakness led to respiratory impairment in patients with stroke [11].

Possible mechanism of respiratory impairment in strokes with bilateral hemisphere involvement is that stroke may lead to weakness of inspiratory and expiratory muscles, which hamper the mechanism of breathing in individuals which lead to reduce respiratory parameters, such as peak expiratory flow rate, and cause respiratory impairment.

Stroke may lead to damage to area of brain responsible for control of respiration such as brainstem and motor cortex. This damage led to loss of coordination between respiratory muscles and higher center lead to muscular weakness which led to respiratory impairment in stroke patients.

This study had some limitations; the study’s sample was predominantly composed of ischemic stroke patients (81.1%) with only (18.9%) of participants experiencing hemorrhagic strokes. This imbalance could skew the results and limit the study’s ability to detect differences in respiratory function between these two groups. Hemorrhagic strokes tend to be associated with different patterns of neurological damage and recovery trajectories, which may influence respiratory outcomes differently. Also, the study population was not homogeneous in terms of stroke severity, lesion location, or comorbidities, which could have influenced the respiratory outcomes. A future study can be performed to assess the impact of CVA on respiratory parameters in accordance with different area involvement of lesion.

CONCLUSION

This study highlights the significant prevalence of respiratory impairment in stroke patients, particularly those with bilateral hemisphere involvement. The strong negative correlation between Peak Expiratory

Flow Rate (PEFR) and the Rate of Dyspnea (RDOS) underscores the critical role of respiratory function in stroke recovery. Despite the absence of significant associations between demographic factors (such as age, sex, and stroke type) and respiratory impairment, the findings suggest that stroke-induced respiratory muscle weakness plays a key role in reducing lung capacity and increasing dyspnea. These results emphasize the importance of incorporating respiratory-focused interventions into stroke rehabilitation programs to improve respiratory function and overall patient outcomes.

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