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CASE REPORT OBSTETRIC ANESTHESIA

# Respiratory muscle training improves respiratory function in a post-cesarean section stroke patient: a case report

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## ABSTRACT

Impaired motor function is a common and persistent consequence of stroke, often leading to respiratory muscle weakness, reduced thoracic expansion, and postural trunk dysfunction. This case report examines the effectiveness and safety of respiratory muscle training (RMT) in improving respiratory function in post-sectio cesarean stroke patient. Over a three-week RMT intervention, patients demonstrated an average increase in forced vital capacity (FVC) of 1.68 L and forced expiratory volume in one second (FEV1) of 0.99 L. The intervention was safe for post-sectio cesarean stroke patient, with no adverse effects reported. These findings suggest that RMT is not only a practical but also a secure component of pulmonary rehabilitation for post-sectio cesarean stroke patients, offering additional benefits beyond conventional stroke rehabilitation programs.

**Abbreviations:** FVC: forced vital capacity, $FEV_1$: forced expiratory volume in one second, RMT: respiratory muscle training,

**Keywords:** FCV; $FEV_1$; Rehabilitation; Respiratory Muscle Training; Stroke

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## 1. INTRODUCTION

Stroke is the leading cause of long-term disability worldwide, so patients who experience stroke generally require assistance in meeting their daily needs.[1] The recorded incidence of stroke in the world is around 200 per 100,000 people per year.[2] In Indonesia, it is estimated that every year, there are 500,000 people affected by stroke, and around 25% or 125,000 people die while the rest experience mild disabilities and can even become severe disabilities. Stroke is the third leading cause of death and is the most significant cause of permanent disability in Indonesia.[3] Motor dysfunction is one of the most frequent and persistent consequences of stroke, which not only involves peripheral muscles in post-stroke disability but also causes respiratory muscle weakness, decreased thoracic expansion ability, and postural trunk dysfunction.[4] The cardiopulmonary function of patients with hemiplegia caused by stroke is reduced due to decreased expansion of the damaged hemithorax and decreased ability of the respiratory muscles.[1] Other literature explains that stroke patients generally experience changes in breathing patterns, decreased ventilation function, decreased respiratory muscle strength, and reduced diaphragm activity on the paralyzed side.[5]

Post-stroke respiratory system disability is associated with dysphagia and ineffective cough, which can increase the risk of aspiration pneumonia, which is noted as the leading cause of nonvascular death after stroke.[6] Poststroke pneumonia (PSP) is a common complication during the first few weeks after stroke, with incidence rates ranging from 2% to 57% in different studies, with a median of 10%.[7] The reported incidence of PSP is highest in intensive care patients (4.1% to 56.6%). In contrast, in acute stroke units, general wards, and rehabilitation units, the reported incidence of PSP ranges from 3.9% to 45%, with a median incidence rate of 7.4%.[8] Patients with PSP have higher mortality rates, more extended hospital stays, worse functional outcomes, and higher care needs.

Based on decreased respiratory muscle strength in stroke patients, respiratory muscle training (RMT) is a specific rehabilitation that targets improving decreased respiratory function and reducing the risk of pneumonia in post-stroke patients.[9] RMT loads the respiratory muscles beyond the usual level of function, strengthening the respiratory muscles so that respiratory function in stroke patients can increase. RMT consists of applying inspiratory and expiratory muscle training or a combination of inspiratory and expiratory muscle training. In RMT, patients are asked to perform repeated breathing exercises against external loads, using flow-dependent resistance or pressure threshold. Respiratory muscles with more loads require them to work longer at higher intensity, and more frequently.[5]

While RMT has been studied extensively in non-pregnant populations with stroke, its application in post-sectio cesarean stroke patient remains significantly underexplored. Sectio cesarean itself imposes additional physiological demands on the respiratory system, further complicating the management of respiratory dysfunction in pregnant stroke patients. The scarcity of studies evaluating the safety and efficacy of RMT in this group underscores the need for targeted research to guide clinical practice. This case report seeks to address this gap by identifying the effectiveness and safety of RMT in improving respiratory function among post-sectio cesarean stroke patient. By providing evidence of its benefits and safety, this study aims to expand the understanding of RMT as a viable rehabilitation intervention for this unique and underrepresented population.

## 2. CASE REPORT

This case report includes pregnant women with stroke who underwent RMT during their inpatient treatment. Before initiating the intervention, the research team conducted an informed consent process with each patient and their families. During this process, the purpose, benefits, potential risks, and detailed procedures of the RMT intervention were thoroughly explained. Additionally, patients were informed about the intention to publish the findings of this study while ensuring their confidentiality and anonymity. Written consent was obtained for participation in the intervention and the publication of the case report.

Before the RMT intervention, baseline respiratory function was assessed using spirometry. The patients participated in RMT sessions conducted for 30 minutes twice daily, five days a week, over a period of three weeks. The patients were closely monitored during each session to ensure proper technique and identify potential adverse effects. At the end of the three-week program, respiratory function was reassessed using spirometry to evaluate the effectiveness of RMT. Changes in respiratory parameters, including forced vital capacity (FVC) and forced expiratory volume in one second ($FEV_1$), were analyzed to determine the intervention's impact on respiratory function. All data in the published report were anonymized to protect patient identity.

The intervention was carried out on Mrs. S (33 years old) with a diagnosis of hemorrhagic stroke and hypertension. The patient was pregnant with her second child at 36 weeks of gestation when she finally experienced a decrease in consciousness and was diagnosed with hemorrhagic stroke. Due to the hemorrhagic stroke experienced by the patient during pregnancy, the patient underwent a CS operation and was then treated in the ICU and then treated in the inpatient room on the tenth day of stroke onset. The patient experienced right hemiparesis. Initially, the patient had difficulty inhaling, which could cause the ball to rise, but after that, the researcher explained that the way to inhale was like inhaling water through a straw. The patient was given a straw and instructed to inhale. After that, the patient could lift the first ball on the incentive spirometry. The patient was treated for 1 week, so the researcher monitored the RMT procedure via the WhatsApp application in the second and third weeks. The patient reported that in the third week of RMT, the patient could lift two balls in the incentive spirometry.

The respiratory function studied in stroke patients before and after respiratory muscle training consisted of forced vital capacity (FCV) and forced expiratory volume in one second ($FEV_1$). Measurement of respiratory function in stroke patients was carried out before and after Respiratory Muscle Training for three weeks. The average respiratory function of the three stroke patients can be seen in Table 1.

Table 1 shows the FVC of patient before RMT and after RMT with a mean difference of 1.68; while for the $FEV_1$ value, before RMT and after RMT, the difference 0.99 L.

**Table 1: Overview of respiratory function of stroke patients before and after RMT**

| Respiratory Function | Pre RMT | Post RMT | Mean Difference |
|---|---|---|---|
| **FVC (L)** | 1.09 | 2.77 | 1.68 |
| **FEV1 (L)** | 1.04 | 2.03 | 0.99 |

*FVC: Forced vital capacity; FEV1: Forsed espiratory volume in one second*

## 3. DISCUSSION

The results of the application of RMT in post-sectio cesarean stroke patient resulted in an increase in FVC of 1.68 L and a change in $FEV_1$ after RMT of 0.99 L. In a systematic review article, the application of RMT showed significant results in improving respiratory function, where the results of the meta-analysis showed an increase in FVC of 1.99 L and $FEV_1$ of 1.22 L in 3 weeks after RMT.[4] The patient's respiratory function was assessed using spirometry, where the FVC and $FEV_1$ values were used as a reference in assessing the patient's respiratory function. This is because FVC and $FEV_1$ have lower variability than other indices, so they are often used to evaluate prognosis and observe the development of respiratory function.[1]

Forced vital capacity (FVC) is the amount of air that can be exhaled in one breath, while forced expiratory volume in one second ($FEV_1$) is the amount of air exhaled in one second.[11] In the implementation of the intervention, incentive spirometry provides RMT to patients. This is based on the advantages of using incentive spirometry, namely: (1) easy to learn so that it can also be easily used; (2) economical; and (3) patient can be motivated to use it because it produces visible achievements. Visual feedback helps trained patients use the instrument independently and freely to maximize motivation in improving respiratory ability.

The study's results explained that an increase in residual capacity or a decrease in lung volume in stroke patients causes the weakening of the inspiratory and expiratory muscles.[1] Improved respiratory function, as indicated by increased FVC and $FEV_1$ in stroke patients, is associated with increased respiratory muscle strength after RMT.[4] The RCT article explained that the RMT intervention was targeted to overcome central respiratory weakness related to stroke, so it was hypothesized to improve lung function and ultimately reduce the risk of stroke-related pneumonia.[9]

A systematic review explains that RMT can improve respiratory function in stroke patients who experience significant respiratory muscle disorders due to decreased cardiorespiratory outflow from the damaged cortex.[11] RMT is based on the premise that respiratory muscles respond to training stimuli by adapting to the respiratory muscle structure when their fibers are overloaded. Respiratory muscles with more loads require them to work longer at higher intensities, and more frequently. Also, because respiratory muscle training not only imposes resistance on the respiratory muscles but also consists of hyperventilation for an extended period, it can have an additional effect on respiratory muscle endurance to be more efficient.[5]

In this case report, after RMT was performed 10-15 times, each session was adjusted to the patient's ability; the patient was then advised to take a deep breath and cough 2-3 times. As previously stated, coughing is an important mechanism to protect the airway and is often impaired in stroke patients, which can lead to lung infections. Therefore, prevention of stroke-related pneumonia is also carried out by increasing the effectiveness of coughing through breathing training.[10] A report of RMT procedures carried out in the application of RMT are thought to improve respiratory function in post-sectio cesarean stroke patient so that RMT as pulmonary rehabilitation is feasible and has additional benefits for lung function compared to conventional stroke rehabilitation programs.

## 4. CONCLUSION

Respiratory muscle training (RMT) can cause an average increase in FVC after RMT of 1.68 L and $FEV_1$ of 0.99 L. The implementation of RMT procedures must always be adjusted to the condition and ability of the individual patient. In our patient, RMT procedures improved respiratory function in post-cesarean stroke patient, so RMT as pulmonary rehabilitation is feasible and has additional benefit for improving lung function as compared to conventional stroke rehabilitation programs.

### 4. Ethical considerations

Detailed informed consent was taken from the patient and her parents prior to data collection and manuscript writing. Anonymity of the patient has been confirmed.

### 5. Conflict of interest

 

None declared by the authors. No external or industry funding was involved.

## 6. Authors contribution

IMK: Concept, study design, and manuscript drafting.

AG: Manuscript editing, critical revision, and guidance on respiratory muscle training interventions.

RS: Data analysis and interpretation, as well as manuscript drafting.

KR: Case management, data collection, and manuscript review.

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