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Effectiveness of Triflow Volume and Segmental Breathing in Post-Laparoscopic Splenectomy Patients - A Case Series

Chaithra B Shetty[1], Vishnu K Nair[2], Naseema M H[3]

[1]Assisstant Professor, [2]Assistant Professor, [3]PG student,
Laxmi Memorial College of Physiotherapy, Mangaluru, India
Rajiv Gandhi University of Health Sciences, Bangalore, Karnataka, India.

Corresponding Author: Naseema M H

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ABSTRACT

Background: Laparoscopic splenectomy (LS) is now the preferred method for elective spleen removal. Compared to traditional open surgery, this minimally invasive approach offers patients faster recovery times, less postoperative pain, shorter hospital stays, and a lower risk of lung-related complications.
Objective: To assess the effectiveness of triflow volume and segmental breathing in post laparoscopic splenectomy patients.
Methods: Nine patients who underwent laparoscopic splenectomy were enrolled using purposive sampling. Data on dyspnea, chest expansion, and functional health status were collected before and after two weeks of intervention. Statistical analysis was performed using SPSS version 29.0 (IBM SPSS Statistics for Windows, Version 29.0; IBM Corp., Armonk, NY).
Results: All nine post-laparoscopic splenectomy patients demonstrated significant improvement following the two-week Physiotherapy intervention. The mean mMRC dyspnea score significantly decreased from 2.889 to 0.444 ($p < 0.001$), and the mean FDQ score reduced from 111.333 to 25.333 ($p < 0.001$). Additionally, chest expansion pattern improved in all patients from 01:01:01 at baseline to 1:2:1 at follow-up, indicating enhanced thoracic mobility and functional recovery.
Conclusion: The combination of Triflow volume and segmental breathing exercises resulted in a significant reduction in dyspnea severity, along with improvements in chest expansion and functional disability in post-laparoscopic splenectomy patients. The intervention appears to be an effective and practical strategy for enhancing early postoperative respiratory recovery.

Keywords: Modified Medical Research Council, Functional Difficulties Questionnaire (FDQ), Triflow volume and Segmental breathing.

INTRODUCTION

As a key lymphoid organ, the spleen is vital for bridging innate and adaptive immune responses. It is especially indispensable for filtering out encapsulated bacteria, removing parasites living within red blood cells, and boosting the body's reaction to vaccines that target polysaccharide antigens.[1] A splenectomy is the surgical removal of the spleen, usually required when a patient experiences severe physical trauma, specific blood disorders, or certain types of cancer.[2] The technique for laparoscopic splenectomy (LS) was pioneered in the early 1990s. While Delaitre

et al. first performed the procedure on adults in 1991, its application in pediatric surgery followed shortly after, introduced by Tulman et al. in 1993.[3] Laparoscopic splenectomy is widely considered a viable option for most patients. While it typically involves longer surgery times than an open procedure, it offers several clinical advantages, including reduced blood loss, lower rates of complications, and a faster hospital recovery.[4]

As spleen is responsible for filtering out old red blood cells and managing platelet levels, removing it (splenectomy) can disrupt your blood's natural balance. This imbalance may lead to a higher risk of venous thromboembolism (VTE)—such as blood clots in the legs or lungs—as well as serious cardiovascular events like heart attacks and strokes.[5] Laparoscopic splenectomy (LS) is associated with potential cardiac complications, including myocardial infarction and arrhythmias, as well as pulmonary issues such as pneumonia, pulmonary embolism, pleural effusion, and left lower lobar atelectasis. Notably, the incidence of respiratory complications can be significantly reduced through rigorous postoperative pulmonary care.[6] In-hospital respiratory exercises have been demonstrated to improve pulmonary ventilation, thoracic mobility, and systemic oxygenation. Furthermore, these interventions strengthen the respiratory musculature and enhance the efficacy of the cough reflex. Furthermore, these exercises reduce the effort required to breathe and serve as a vital preventative measure against postoperative pulmonary complications.[7]

Incentive spirometry (IS) is a therapeutic breathing tool designed to help patients perform deep, sustained inhalations that mimic natural sighing. This device provides real-time visual feedback, encouraging the slow, profound breaths necessary to maintain lung function.[8] The use of Triflow has been demonstrated to foster a more deliberate and steady breathing pattern. Specifically, it encourages longer inhalations and a slower respiratory rate, which reduces the patient's dependence on accessory muscles. Furthermore, the integrated visual feedback helps refine breathing techniques and boosts patient engagement.[9,10]

Segmental breathing techniques are utilized to target and enhance expansion in specific, localized areas of the lungs. This method involves deep inhalations followed by relaxed exhalations, directed by applying physical stimulation or pressure to the particular section of the chest wall where lung volume or movement has diminished.[11]Segmental breathing exercises are designed to achieve several clinical objectives, primarily by enhancing lung aeration and chest wall expansibility. These improvements significantly lower the risk of atelectasis. Additionally, the technique stimulates the cough reflex, which is essential for clearing the bronchial tree and preventing the dangerous accumulation of mucus and secretions.[12]

While the advantages of postoperative respiratory physiotherapy are well-established, there is a lack of specific research on the combined impact of Triflow volume training and segmental breathing exercises following laparoscopic splenectomy. Considering that upper abdominal surgeries frequently result in decreased lung volumes and a high risk of pulmonary complications, specialized respiratory interventions are likely essential for recovery. Therefore, this case series aims to evaluate the effect of Triflow volume and segmental breathing exercises on respiratory outcomes in post-laparoscopic splenectomy patients, thereby contributing to evidence-based physiotherapy practice in the early postoperative period.

MATERIALS & METHODS

Type of study - Case series.

Sample and Setting-

Patients were recruited from a tertiary care hospital in Mangaluru, Karnataka, India, between July 10, 2025, and September 24, 2025. Nine consecutive patients who

underwent laparoscopic splenectomy were included in this case series. Inclusion criteria comprised adults who had undergone laparoscopic splenectomy, were hemodynamically stable, and were willing to participate in the study. All patients were under routine postoperative medical management during the study period. Patients were assessed for dyspnea, chest expansion, and functional health status. Outcome measures including the modified Medical Research Council (mMRC) dyspnea scale, chest expansion, and Functional Disability Questionnaire (FDQ) were recorded on the first postoperative day and after two weeks of intervention. Exclusion criteria included patients with pre-existing severe cardiopulmonary disorders, postoperative complications requiring intensive care, or any condition contraindicating respiratory physiotherapy. All participants received supervised physiotherapy once daily for two weeks, consisting of Triflow volume and segmental breathing exercises.

Outcomes measures-

Including mMRC dyspnea grade, chest expansion and Functional Disability Questionnaire (FDQ) were measured before and after the intervention to evaluate the effectiveness.

a) mMRC Dyspnea Scale-
   The modified Medical Research Council (mMRC) dyspnea scale is a clinical tool used to categorize functional disability by identifying the specific activity levels that trigger shortness of breath. While the original MRC scale utilized a 1–5 grading system, the widely adopted modified version uses a 0–4 scale with nearly identical descriptors. Rather than measuring the immediate intensity of breathlessness, the mMRC evaluates how significantly respiratory distress limits daily life—ranging from breathlessness only during intense exertion (Grade 0) to being unable to leave the house due to symptoms (Grade 4). With a high test–retest reliability (ICC = 0.82), the mMRC is considered a highly dependable instrument for assessing dyspnea-related disability in both research and clinical practice.[13,14]

b) Chest expansion
   Chest expansion is clinically defined as the numerical difference in thoracic circumference between a state of maximal exhalation and maximal inhalation. This assessment of thoracic mobility is performed using a non-stretchable measuring tape, offering a cost-effective and straightforward diagnostic technique. During the procedure, the subject stands with an exposed chest and hands resting on their hips with elbows slightly flexed. Measurements are taken at three specific anatomical landmarks: the upper thoracic level (axilla/2nd intercostal space), the middle thoracic level (nipple/4th or 5th intercostal space), and the lower thoracic level (xiphoid process). To obtain the data, the subject is instructed to perform a full expiration followed by a maximal deep inspiration; the difference between these two points is recorded as the expansion value. For accuracy, three trials are conducted at each level, and the average is used for final analysis. While a difference exceeding 5 cm is generally considered normal, healthy ranges typically fluctuate between 4 and 7 cm. Conversely, chest expansion is notably reduced in patients with lung pathologies, with values declining as disease severity increases. Furthermore, normal thoracic expansion naturally diminishes with age, often decreasing by 50%–60% between the ages of 15 and 75.[15,16]

c) Functional Difficulties Questionnaire (FDQ)
   The Functional Disability Questionnaire (FDQ) consists of 13 specific daily activities identified by researchers as essential tasks requiring thoracic movement. These functional items include sitting upright, walking with a

natural arm swing, coughing or sneezing, and various mobility tasks like rolling over or getting out of bed. Personal care and reaching movements are also evaluated, such as washing hair, scratching or drying the back, picking up items from the floor, reaching backward, fastening clothing (like a bra or tucked-in shirt), donning a jacket, and closing a drawer. Statistically, the FDQ's overall mean score demonstrated exceptional test–retest reliability, with an intraclass correlation coefficient (ICC 2,1) of 0.918, confirming it as a highly dependable tool for clinical assessment.[17]

Statistical Analysis

Statistical analysis was performed using SPSS version 29.0 (IBM SPSS Statistics for Windows, Version 29.0; IBM Corp., Armonk, NY). Descriptive statistics were expressed as frequencies and percentages for categorical variables, while continuous variables were summarized using mean and standard deviation. Pre-Post comparison was done using paired t test. A p value <0.05 was considered statistically significant.

RESULT

The findings indicate that all nine post-laparoscopic splenectomy patients demonstrated significant improvements following the two-week physiotherapy intervention. The mean mMRC dyspnea score significantly decreased from 2.889 ± 0.601 at baseline to 0.444 ± 0.527 at follow-up (mean decrement = 2.444; t = 13.914, p < 0.001), indicating a marked reduction in breathlessness. Similarly, the mean FDQ score showed a substantial reduction from 111.333 ± 9.274 to 25.333 ± 4.000 (mean decrement = 86.000; t = 37.239, p < 0.001), reflecting significant improvement in functional status. Furthermore, chest expansion patterns improved in all patients, with 100% demonstrating a change from a 01:01:01 pattern at baseline to a 1:2:1 pattern at follow-up, indicating enhanced thoracic mobility.

Table 1: Comparison of MMRC Scores at Baseline and Follow-up among Post-Laparoscopic Splenectomy Patients

		Mean	Std. Deviation	Decrement	t value	p value
MMRC	Baseline	2.889	0.601	2.444	13.914	p<0.001*
	Follow up	0.444	0.527			

The mean MMRC score at baseline was 2.889 ± 0.601, which decreased to 0.444 ± 0.527 at follow-up, showing a mean decrement of 2.444. The reduction in MMRC scores was found to be statistically highly significant (t = 13.914, p < 0.001).

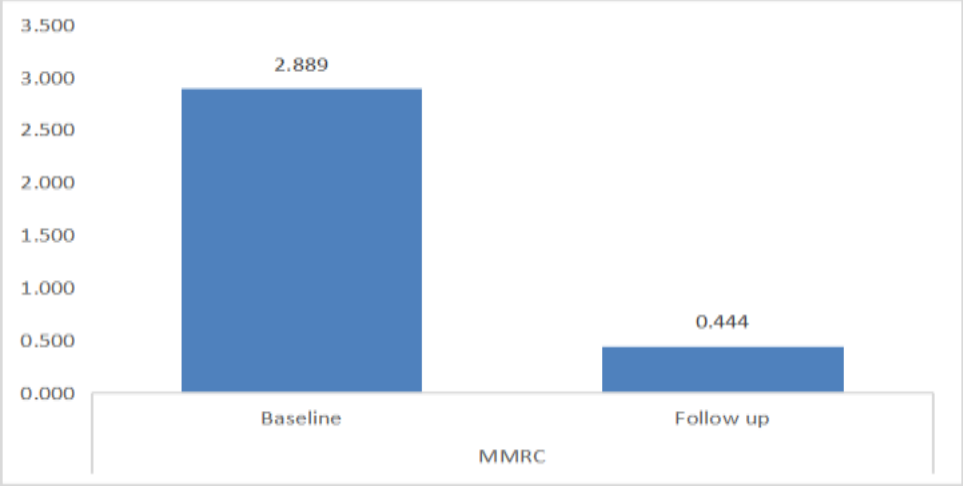

Figure 1: Representing Mean MMRC Score Distribution at Baseline and Follow-up

Table 2: Comparison of FDQ Questionnaire Scores at Baseline and Follow-up among Post-Laparoscopic Splenectomy Patients

		Mean	Std. Deviation	Decrement	t value	p value
FDQ questionnaire	Baseline	111.333	9.274	86.000	37.239	p<0.001*
	Follow up	25.333	4.000			

The mean FDQ questionnaire score at baseline was 111.333 ± 9.274, which markedly reduced to 25.333 ± 4.000 at follow-up, showing a mean decrement of 86.000. The reduction in FDQ scores was statistically highly significant (t = 37.239, p < 0.001).

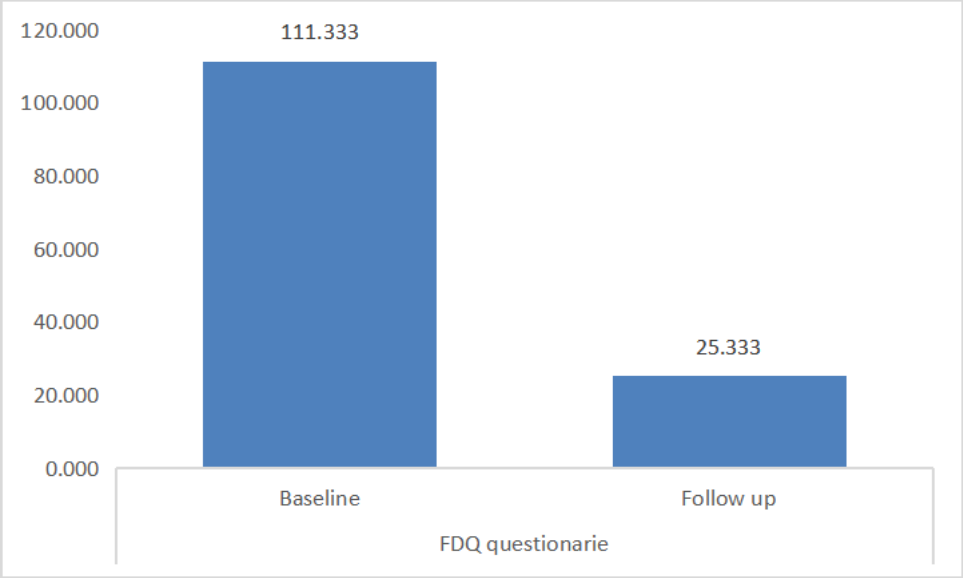

Figure 2: Representing Mean FDQ Questionnaire Score Distribution at Baseline and Follow-up

Table 3: Chest Expansion Pattern at Baseline and Follow-up among Post-Laparoscopic Splenectomy Patients

Chest Expansion		Frequency	Percentage
Baseline	01:01:01	9	100%
Follow up	1:2:1	9	100%

At baseline, all patients demonstrated a chest expansion pattern of 01:01:01 [9 (100%)]. At follow-up, all patients demonstrated a chest expansion pattern of 1:2:1 [9 (100%)].

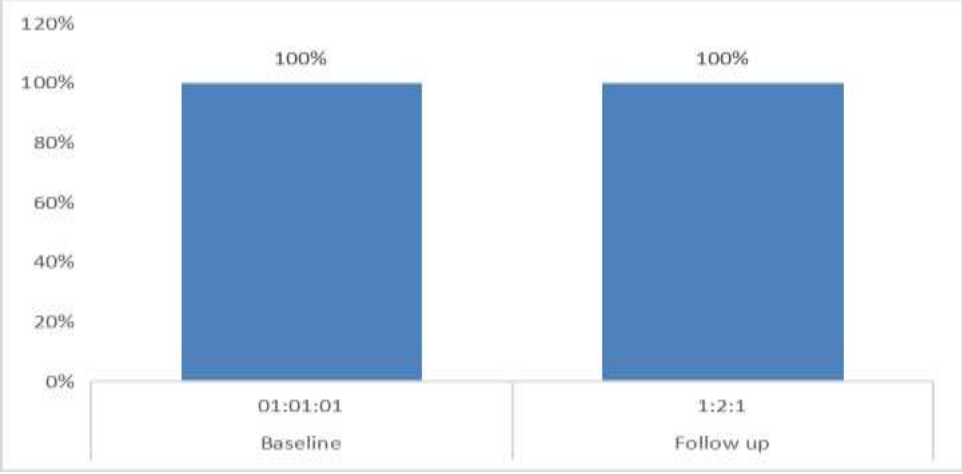

Figure 3: Representing Frequency Distribution of Chest Expansion Pattern at Baseline and Follow-up

DISCUSSION

In this case series, we observed that Triflow volume exercise combined with segmental breathing in post-laparoscopic splenectomy patients led to significant improvements in mMRC dyspnea scores, chest expansion, and Functional Disability Questionnaire (FDQ) scores over the intervention period. Although laparoscopic splenectomy is minimally invasive, it still affects respiratory mechanics due to upper abdominal surgical trauma, postoperative pain, and diaphragmatic inhibition. These factors commonly result in shallow breathing, reduced lung volumes, and increased risk of atelectasis in the early postoperative phase.

Post-upper abdominal surgeries commonly result in shallow breathing, reduced diaphragmatic excursion, pain-induced splinting, and decreased chest wall mobility, all of which can impair oxygenation and delay recovery. In this context, Triflow volume exercises promote sustained maximal inspiration and alveolar recruitment, while segmental breathing improves localized lung expansion and thoracic compliance. Together, these interventions address both mechanical and functional respiratory limitations.

Complementing this, Gaikwad and Shukla (2024) conducted a randomized controlled trial to evaluate the effect of segmental expansion exercises in patients undergoing upper abdominal surgery. Their study demonstrated significant improvements in pulmonary function parameters and chest wall mobility in the intervention group compared to controls. The authors emphasized that targeted segmental breathing enhances localized lung ventilation, improves thoracic compliance, and counteracts postoperative diaphragmatic dysfunction caused by pain and surgical manipulation.[16] These findings provide physiological support for the improvements in chest expansion and dyspnea observed in our case series following laparoscopic splenectomy.[18]

Similarly, Devmurari et al. (2025) investigated the effectiveness of adding flow-oriented incentive spirometry to conventional physiotherapy in postoperative upper abdominal surgery patients. The intervention group showed superior improvements in functional capacity, particularly in measures such as the six-minute walk distance, along with better preservation of pulmonary outcomes compared to physiotherapy alone. The study highlighted that sustained maximal inspiration using flow-oriented devices promotes alveolar recruitment and prevents postoperative atelectasis. These results reinforce the clinical value of Triflow-type interventions in enhancing respiratory recovery and functional performance in postoperative patients.[19]

Furthermore, a comprehensive review by Ababneh et al. (2025) concluded that both incentive spirometry and deep breathing exercises enhance oxygenation, promote alveolar expansion, and reduce postoperative pulmonary complications. Improved oxygen delivery and reduced breathlessness facilitate early mobilization, which directly influences functional recovery and disability levels. This may explain the observed improvement in FDQ scores in patients, as better respiratory efficiency translates into improved tolerance to daily activities.[20]

Beyond physiological improvements, the integration of structured breathing exercises in the early postoperative phase may also enhance patient confidence, reduce fear-avoidance behavior related to pain or breathlessness, and accelerate return to functional independence.

Overall, these findings align with existing literature supporting segmental breathing exercise and triflow volume as safe, effective, and practical interventions in upper abdominal surgery rehabilitation. Future studies with larger sample sizes are recommended to validate these findings and develop standardized evidence-based postoperative respiratory rehabilitation protocols.

CONCLUSION

This case series concludes that Triflow volume combined with segmental breathing exercises is effective in improving respiratory and functional outcomes in post-laparoscopic splenectomy patients. Significant reductions in dyspnea (mMRC) and functional disability (FDQ), along with improved chest expansion, were observed after two weeks of intervention. The findings suggest that structured postoperative respiratory physiotherapy enhances lung expansion and facilitates early functional recovery. These interventions appear to be safe, practical, and beneficial in upper abdominal surgical rehabilitation.

Declaration by Authors

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