



A STUDY TO EVALUATE THE PERIOPERATIVE RESPIRATORY MECHANICS IN PATIENTS UNDERGOING LAPROSCOPIC ABDOMINAL SURGERIES USING FORCED OSCILLATION TECHNIQUE

Pulmonary Medicine

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ABSTRACT

Need For Study Perioperative prediction of respiratory complications is important in patients undergoing laparoscopic surgeries under general anesthesia. Spirometry- most frequently used method for perioperative evaluation of respiratory function, but it is effort dependent. Forced oscillation technique (FOT) overcomes this problem as it is a simple, effortless and non-invasive means of assessing the respiratory mechanics. The technique involves external application of pressure wave to the respiratory system while the patient is breathing normally at tidal volume followed by measurement of airflow. It is capable of detecting respiratory changes due to endotracheal intubation, duration of general anesthesia and carbon dioxide insufflation both in airway (blocks, narrowing, spasms) as well as parenchyma (consolidation, atelectasis or collapse). In our study, we intend to analyze these changes in patients undergoing laparoscopic abdominal surgeries under general anesthesia which may help in early detection and in turn guide to decrease the incidence of respiratory complications.

Aim&objective-

- 1) To evaluate the changes in respiratory resistance and reactance in patients undergoing laparoscopic abdominal surgeries using Forced Oscillation Technique before and after surgery.
- 2) To evaluate the clinical profile of patients with significant changes.

Materials And Methods- This is an ongoing prospective-observational study started in November 2022 at hospitals attached to Bangalore Medical College and Research Institute (BMCRI). After obtaining ethical committee clearance, an informed written consent was taken from 12 patients were enrolled into the study. FOT test was performed 24 hours before and 24 hours after surgery and results were tabulated using SPSS version 27 and calculated with student t-test. **Results:-** Out of 12 cases, respiratory reactance at 5 Hz (R5) and respiratory resistance of R5-20 (small airway) changed significantly in 4 patients (36%) who underwent surgery for more than 2 hours duration. Respiratory reactance (X5) changed significantly in 6 (50%) patients who underwent laparoscopic surgery for more than 2 hours. The study is currently ongoing and the final results will be displayed on the day of presentation. **Conclusion:-** The forced oscillation technique is a clinical tool that can be used to predict respiratory mechanics before and after surgery. However, it remains to be seen that, it plays a role in predicting clinical outcomes in terms of reducing postoperative morbidity.

KEYWORDS

INTRODUCTION:

In Laparoscopic surgeries with general anaesthesia, it becomes important to predict the perioperative respiratory complications. Spirometry is the most frequently used method for perioperative evaluation of respiratory function but it is effort dependent. Therefore, spirometry tends not to be used postoperatively. Postoperative respiratory function is usually determined by measuring peripheral oxygen saturation and arterial blood gas analysis. However, these methods cannot assess postoperative respiratory deterioration. This difficulty may be overcome by using Forced oscillation technique (FOT).¹

FOT is a simple, effortless and non-invasive means of assessing the respiratory mechanics, first described by Dubois et al. in 1956.² The technique involves the external application of pressure wave to the respiratory system during tidal breathing followed by measurement of airflow.³ Initially FOT was used for evaluation and management of obstructive airway diseases such as COPD and asthma.⁴ It is capable of detecting respiratory changes due to endotracheal intubation, duration of general anaesthesia and carbon dioxide insufflation both in airway (blocks, narrowing, spasms) as well as parenchyma (consolidation, atelectasis or collapse)

FOT measures the two components of respiratory impedance, respiratory resistance (Rrs) and respiratory reactance (Xrs), measured over a wide range of oscillatory frequencies. Rrs is a measure of central and peripheral airway calibers responsible for resistance exerted from the oropharynx to the lung and chest wall. Xrs is directly related to elastic properties at lower frequency and inertive properties at higher frequencies.⁵ Rrs and Xrs measurements allow better understanding of

pathophysiology, evaluation of therapeutic response and treatment optimization.⁶

FOT is capable of measuring resistance and reactance but not other parameters of respiratory mechanics like flow, pressure, volume, compliance, and work of breathing.

In this study, we intended to analyze changes in the respiratory mechanics (with respect to resistance and reactance) of patients undergoing laparoscopic abdominal surgeries under general anaesthesia at our institution.

MATERIALS AND METHODS

The objective of the study to evaluate the changes in respiratory resistance and reactance in patients undergoing laparoscopic abdominal surgeries using Forced Oscillation Technique.

Patients admitted as inpatients to Victoria Hospital, attached to Bangalore Medical College and Research Institute, Bangalore between November 2022 to March 2023 were included in this study after obtaining their consent and institutional ethical clearance.

This was a Cross sectional observational study which included patients aged above 18 years, undergoing Laparoscopic abdominal surgeries under General Anaesthesia and willing to give informed consent

Sample size was calculated according to the study conducted by Kuzukawa Y et al^[3], where the Mean duration of surgery was 170 minutes with Standard Deviation (SD) as 104 minutes. A total sample size of 50 patients was calculated for this study but the study was

continued further and included a total of 62 patients.

This study excluded known cases of COPD, Asthma or with history of asthmatic symptoms, chronic smokers, patients of recent history of respiratory tract infections or exacerbations, using oral steroids within previous 3 months, patients with cardiac disorders and those not willing to give consent to take part in this study

A detailed history of respiratory symptoms was elicited by interviewing the patients. The socio-demographic and details as per the proposed proforma was obtained and entered and then the patients were clinically examined thoroughly. Patients were then subjected to FOT and the respiratory parameters were measured 24 hours before and 24 hours after surgery. The duration of the surgery performed was also be taken into account for correlation.

Forced Oscillation Technique: The THORASYs tremflo C-100 Airway Oscillometry System (AOS) was used. The results were measured and values in accordance with age, sex and height of the patients were noted. The FOT measurements were done for Respiratory resistance (Rrs) at 5 Hz (R5), 20 Hz (R20). R5-20 was calculated and Respiratory reactance (Xrs) was measured at 5 Hz (X5), area under curve (AX) and fres was calculated.

Outcome measures of this study were R5, R20, R5-20, X5, AX, fres, Duration of Surgery, Duration of General anesthesia and need for post operative ventilatory support and its duration.

Statistical analysis:

The data collected was entered into Microsoft excel sheet and was analysed using SPSS version 24.0. Sociodemographic data was presented using descriptive statistics namely mean, median, standard deviation, interquartile range (IQR), percentage wherever applicable. Comparison of the before surgery and after surgery values from the Forced Oscillation Technique results as well as its correlation with the duration of surgery was analysed using appropriate parametric and non-parametric tests such as chi-square test for categorical variables and Pearson's correlation for continuous variables to look for significant association between the variables. P-value <0.05 was considered statistically significant.

RESULTS:

All the 62 cases completed the study. None of the patients needed ICU care or ventilator support. Most of our patients (59.7%) were aged between 40 to 60 years and majority of them were female – 62.9%

50% (31) of patients had duration of surgery less than 2 hours and 50% (31) of patients had duration of surgery of more than 2 hours. With the mean duration of surgery being 105.32 ± 29.58 minutes.

The mean duration of anesthesia was 118.21 ± 28.16 minutes. The impression derived from the FOT test showed that out of 19 patients who had normal values in the preop examination, only 14 had normal values in the post op examination. 5 showed features of small airway disease. Loss of elasticity of lung parenchyma was seen in 12 patients post op, 10 of which also had total airway obstruction features. These patients were given nebulization and oxygen in their postoperative period. All these 12 cases belonged to the more than 2 hours of surgery group. 3 patients belonging to the more than 2 hours surgery group had features of small airway obstruction as well but were clinically normal.

The surgeries performed were laparoscopic cholecystectomy, laparoscopic appendisectomy, IPOM – intraperitoneal onlay mesh repair, IPOM – plus, laparoscopic sleeve gastrectomy, TEP – total extraperitoneal mesh repair and diagnostic laparoscopy with adhesiolysis. There was no statistically significant difference in the type of surgery performed and changes in the FOT analysis.

Out of the 31 patients with duration of surgery less than 2 hours, all FOT parameters except Fres were found to be statistically significant after surgery compared to before with a p value of ≤ 0.000 as shown in table 1.

Table 1: FOT analysis before and after surgery in patients with less than 2 hours duration of surgery.

< 2 Hrs						
Parameter	Operative	Mean	Std. Deviation	Mean Difference	t Value	P Value
R5	Pre	4.45	1.63	1.630	6.385	≤ 0.000
	Post	2.82	1.07			

R20	Pre	3.28	1.42	2.120	7.307	≤ 0.000
	Post	1.16	0.77			
R5-20	Pre	1.21	1.06	3.960	9.068	≤ 0.000
	Post	-2.76	1.63			
X5	Pre	-2.37	1.44	26.340	7.990	≤ 0.000
	Post	23.97	17.17			
AX	Pre	28.01	22.97	14.230	3.617	≤ 0.001
	Post	13.77	18.12			
Fres	Pre	14.93	18.70	1.160	1.388	0.175
	Post	13.77	18.12			

Out of the 31 patients with duration of surgery more than 2 hours, all FOT parameters were found to be statistically significant after surgery compared to before with a p value of ≤ 0.000 as shown in table 2

Table 2: FOT analysis before and after surgery in patients with more than 2 hours duration of surgery.

≥ 2 Hrs						
Parameter	Operative	Mean	Std. Deviation	Mean Difference	t Value	P Value
R5	Pre	5.07	1.86	2.100	7.110	0.000
	Post	2.96	0.81			
R20	Pre	3.24	0.93	2.015	8.231	0.000
	Post	1.23	1.13			
R5-20	Pre	1.77	1.41	5.141	8.353	0.000
	Post	-3.37	2.25			
X5	Pre	-2.79	2.50	31.280	7.514	0.000
	Post	28.50	21.08			
AX	Pre	41.15	31.79	21.820	4.161	0.000
	Post	19.33	11.98			
Fres	Pre	22.17	12.81	2.840	4.411	0.000
	Post	19.33	11.98			

Although FOT showed significant changes in the respiratory parameters before and after surgery, patients were clinically asymptomatic and had a uneventful postoperative period. All patients were discharged within Post op day 3.

FOT parameters were deranged in patients belonging to duration of surgery <2 hours as well as ≥ 2 hours.

DISCUSSION:

It is crucial to know the perioperative outcome for patients undergoing general anesthesia for prolonged duration as there are significant changes in respiratory resistance and reactance. All our patients were non smokers and had no known respiratory disorders yet, our study showed statistically significant changes before and after surgery in R5, R20, AX and Fres after performing FOT. Although this was subclinical in our patients, there is a potential for respiratory complications to occur in them. This could be exacerbated in patients with known cardiopulmonary disorders, COPD or chronic smokers.

A study conducted by Kuzukawa Y et al. at Osaka medical college, Osaka, Japan in 2013, evaluated the perioperative respiratory mechanics of 40 patients undergoing general anaesthesia by FOT. They concluded that the forced oscillation technique is a clinical tool that can be used to assess the effects of perioperative ventilation strategies on respiratory mechanics. This correlated well with our study.⁵

A prospective observational study conducted by Nakano S et al. at Osaka Medical college, Osaka, Japan in 2015, evaluated the perioperative respiratory changes in 26 patients undergoing surgeries under general anaesthesia and mechanical ventilation by FOT. They concluded that all the components measured by FOT deteriorated significantly after a relatively short period of general anaesthesia and mechanical ventilation.¹ Our study had a larger sample size and showed similar results. However Fres did not show significant changes in the patients operated within 2 hours.

A study conducted by Igarashi A et al. at Yamagata University, Yamagata, Japan in 2015, evaluated the perioperative respiratory parameters by performing PFT and FOT in 103 patients undergoing surgeries under general anaesthesia. They concluded that PFTs and FOT did not predict the perioperative respiratory complications.⁷ This was contradictory to the findings in our study. However we had similar

findings with respect to Fres in patients operated within 2 hours .

A study conducted by Zerah-Lancer F et al. at Henri Mondor Teaching Hospital, Creteil, France in 2011, evaluated the airway hyper responsiveness by FOT in a 135 severely obese patients before and after bariatric surgery. They concluded that airway hyperresponsiveness is not related to BMI or sleep apnea syndrome but depended on prolonged duration of anesthesia.⁸ Similarly our study only showed significant changes with respect to duration of anaesthesia but not with BMI.

Thus, large multicentric studies would be required to make FOT a routine clinical tool to assess the perioperative outcome in patients undergoing laparoscopic surgeries under general anaesthesia. Also, FOT has a potential to be especially useful if done preoperatively in patients having known pulmonary disorders or chronic smokers in order to prevent postoperative complications.

CONCLUSION:

The forced oscillation technique is a clinical tool that can be used to predict respiratory mechanics before and after surgery. It plays a role in predicting clinical outcomes in terms of reducing postoperative morbidity.

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