

**Study of Diaphragmatic Mobility by Chest  
Ultrasound and Echocardiographic Changes in  
COPD Patients on Different Modes of  
Mechanical Ventilation**

*Thesis*

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Diseases

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# قالوا

لسببائك لا علم لنا  
إلا ما علمتنا إنك أنت  
العليم العظيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

# Contents

<b>Subjects</b>	<b>Page</b>
List of abbreviations.....	II
List of figures.....	V
List of tables.....	VI
• <b>Introduction</b> .....	1
• <b>Aim of the Work</b> .....	6
• <b>Review of Literature</b>	
♦ <b>Chapter (1): COPD and Mechanical         Ventilation</b> .....	7
♦ <b>Chapter (2): Ultrasound in Assessment of         Diaphragm</b> .....	28
♦ <b>Chapter (3): Echocardiography in Chronic         Obstructive Pulmonary Disease</b> .....	37
• <b>Patients and Methods</b> .....	65
• <b>Results</b> .....	85
• <b>Discussion</b> .....	95
• <b>Conclusion</b> .....	106
• <b>Recommendations</b> .....	107
• <b>Summary</b> .....	108
• <b>References</b> .....	110
• <b>Arabic Summary</b>	

## **List of Abbreviations**

<b>A-P</b>	: Antero-posterior
<b>AR</b>	: Aortic regurgitation
<b>AS</b>	: Assessing aortic stenosis
<b>AV</b>	: Aortic valve
<b>BIPAP</b>	: Dual-pressure ventilation
<b>RVSP</b>	: Right ventricular systolic pressure
<b>RAP</b>	: Right atrial pressure
<b>CBC</b>	: Complete blood count
<b>CO</b>	: Cardiac output
<b>COPD</b>	: Chronic obstructive pulmonary disease
<b>CVP</b>	: Central venous pressure
<b>SIMV</b>	: Synchronized intermittent mandatory ventilation
<b>CPAP</b>	: Continuous positive airway pressure
<b>CW</b>	: Continuous wave Doppler
<b>DE</b>	: Diaphragmatic excursion
<b>DH</b>	: Dynamic hyperinflation
<b>ECG</b>	: Electrocardiograph
<b>FiO<sub>2</sub></b>	: Fraction of inspired oxygen

## *List of Abbreviations*

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<b>ICU</b>	: Intensive care units
<b>IGF-1</b>	: Insulin-like growth factor 1
<b>IMP</b>	: Inosine monophosphate
<b>IMV</b>	: Invasive mechanical ventilation
<b>IPPV</b>	: Intermittent positive pressure ventilation
<b>IVC</b>	: Inferior vena cava
<b>LA</b>	: Left atrial
<b>LVEF</b>	: Left ventricular ejection fraction
<b>MAX</b>	: Maximal expiratory pressure
<b>MV</b>	: Mitral valve
<b>NIV</b>	: Noninvasive ventilation
<b>NO</b>	: Nitric oxide
<b>OTI</b>	: Orotracheal intubation
<b>PaCO<sub>2</sub></b>	: Arterial carbon dioxide pressure
<b>P<sub>AW</sub></b>	: Airway pressure
<b>PCO<sub>2</sub></b>	: Partial pressure of carbon dioxide
<b>PEEP</b>	: Positive end expiratory pressure
<b>PH</b>	: Pulmonary hypertension
<b>PSV</b>	: Pressure support ventilation
<b>PVR</b>	: Pulmonary vascular resistance

## *List of Abbreviations*

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<b>PW</b>	: Pulsed-wave Doppler
<b>RA</b>	: Right atrial
<b>ROI</b>	: Reactive oxygen intermediates
<b>RV</b>	: Right ventricle
<b>SBT</b>	: Spontaneous breathing trial
<b>SID</b>	: Strong ion difference
<b>sPAP</b>	: Systolic pulmonary arterial pressure
<b>SVC</b>	: Superior vena caval
<b>TAPSE</b>	: Tricuspid annular plane systolic excursion
<b>TF</b>	: Thickening fraction
<b>TR</b>	: Tricuspid regurge
<b>TV</b>	: Tricuspid valve
<b>VC</b>	: volume control
<b>VE</b>	: Minute ventilation
<b>V<sub>T</sub></b>	: Tidal volume
<b>2D</b>	: Two-dimensional

## **List of Figures**

<b><u>No.</u></b>	<b><u>Figure</u></b>	<b><u>Page</u></b>
<b><u>1</u></b>	Combined assessment of COPD.	<b>8</b>
<b><u>2</u></b>	Combined assessment of COPD 2017.	<b>8</b>
<b><u>3</u></b>	Sonography of the diaphragm in the zone of apposition, in B-mode (right) and M-mode (left) during quiet breathing.	<b>32</b>
<b><u>4</u></b>	Mechanical and electronic transducers.	<b>38</b>
<b><u>5</u></b>	M mode imaging.	<b>39</b>
<b><u>6</u></b>	Continuous wave Doppler (CW).	<b>40</b>
<b><u>7</u></b>	Pulsed wave Doppler (PW).	<b>41</b>
<b><u>8</u></b>	Patient in left lateral decubitus position.	<b>43</b>
<b><u>9</u></b>	Patient in supine position.	<b>43</b>
<b><u>10</u></b>	Patient in left lateral decubitus position.	<b>44</b>
<b><u>11</u></b>	The marker dot towards the right shoulder.	<b>45</b>
<b><u>12</u></b>	Parasternal long-axis view. Arrows show chordae.	<b>46</b>
<b><u>13</u></b>	The marker dot towards the right shoulder short axis view.	<b>47</b>
<b><u>14</u></b>	Parasternal short-axis views: (a) Aortic valve level. The pulmonary valve is shown (arrow). (b) Mitral valve level. (c) Papillary muscles (arrows) level.	<b>48</b>
<b><u>15</u></b>	The marker dot pointing down towards the left shoulder.	<b>49</b>

## *List of Figures*

---

<b><u>No.</u></b>	<b><u>Figure</u></b>	<b><u>Page</u></b>
<b><u>16</u></b>	Apical views: (a) apical 4-chamber view.(b) Apical 5-chamber view. The aortic valve is shown (arrow). (c) Apical long-axis view.	<b>51</b>
<b><u>17</u></b>	Subcostal 4-chamber view.	<b>52</b>
<b><u>18</u></b>	Transducer tilting to right (subcostal IVC view).	<b>53</b>
<b><u>19</u></b>	IVC view (a) IVC diameter in expiration (b) in inspiration (c) M-mode to assess IVC diameter respiratory variation.	<b>54</b>
<b><u>20</u></b>	RV-focused view.	<b>56</b>
<b><u>21</u></b>	TAPSE measured by M mode.	<b>57</b>
<b><u>22</u></b>	Mindray M7 Ultrasound device.	<b>69</b>
<b><u>23</u></b>	Siemens SONOLINE G60 S system.	<b>69</b>
<b><u>24</u></b>	Diaphragmatic excursion during quiet breathing by M mode US.	<b>71</b>
<b><u>25</u></b>	Diaphragmatic thickness by M mode US.	<b>72</b>
<b><u>26</u></b>	M-mode of left ventricle used to estimate cavity dimensions in systole and diastole, and wall thickness.	<b>74</b>
<b><u>27</u></b>	Assessment of LV ejection fraction by M mode.	<b>75</b>
<b><u>28</u></b>	Measurement of right internal mid cavity dimension.	<b>76</b>
<b><u>29</u></b>	TAPSE measurement by M-mode in apical four-chamber view.	<b>77</b>
<b><u>30</u></b>	Assessment of severity of TR by colour flow Doppler.	<b>79</b>

## *List of Figures*

---

<b><u>No.</u></b>	<b><u>Figure</u></b>	<b><u>Page</u></b>
<b><u>31</u></b>	M-mode trace of inferior vena cava (IVC) recorded from subcostal view just proximal to hepatic vein.	<b>82</b>
<b><u>32</u></b>	Comparison between DE at different mode of mechanical ventilation.	<b>91</b>
<b><u>33</u></b>	Comparison between Diaphragmatic thickness and different modes of mechanical ventilation.	<b>91</b>

## **List of Tables**

<b><u>No.</u></b>	<b><u>Table</u></b>	<b><u>Page</u></b>
<b><u>1</u></b>	LVDd in mm.	<b>73</b>
<b><u>2</u></b>	LVDs in mm.	<b>74</b>
<b><u>3</u></b>	Correlation between IVC Diameter and CVP.	<b>81</b>
<b><u>4</u></b>	Socio-demographic distribution of the studied group.	<b>84</b>
<b><u>5</u></b>	Smoking history, co-morbidity and number of days of mechanical ventilation among the studied group.	<b>85</b>
<b><u>6</u></b>	Descriptive data about parameters of ventilation, diaphragmatic mobility, thickness and echocardiography at assisted volume control mode.	<b>86</b>
<b><u>7</u></b>	Descriptive data about parameters of ventilation, diaphragmatic mobility, thickness and echocardiography at pressure control (BIPAP) mode.	<b>87</b>
<b><u>8</u></b>	Descriptive data about parameters of ventilation, diaphragmatic mobility, thickness and echocardiography at SIMV mode.	<b>88</b>
<b><u>9</u></b>	Descriptive data about parameters of ventilation, diaphragmatic mobility, thickness and echocardiography at pressure support (CPAP) mode.	<b>89</b>

## *List of Tables*

---

<b><u>No.</u></b>	<b><u>Table</u></b>	<b><u>Page</u></b>
<b><u>10</u></b>	Relation between diaphragmatic mobility and diaphragmatic thickness with different modes of mechanical ventilation.	<b>92</b>
<b><u>11</u></b>	Relation between Echocardiography and different modes of mechanical ventilation.	<b>95</b>

## Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by airflow limitation that is not fully reversible and abnormal inflammatory response of the lungs to noxious particles or gases (*Rabe et al., 2007*).

A number of pathophysiological mechanisms of COPD such as airway obstruction, pulmonary hyperinflation and air trapping, might be involved in this process of impairment of diaphragmatic function (*Iwasawa et al., 2002*).

The respiratory muscles constitute a vital component of the respiratory pump. Their contraction during part of the breathing cycle changes the anatomic configuration of the thorax and displaces its components, so that air moves into and out of the gas exchanging portion of the lungs (*Roussos et al., 1982; Rochester et al., 1985*).

Diaphragm is the principal generator of tidal volume in normal subjects at rest. Studies have shown that the impairment of diaphragm mobility might be associated with alterations in the principal pulmonary function parameters (*Unal et al., 2000; (Dos Santos Yamaguti, et al., 2008)*).

The diaphragm is a fundamental respiratory muscle whose dysfunction may be very common in patients undergoing mechanical ventilation. Diaphragm dysfunction is associated with prolonged mechanical ventilation and weaning failure (*Ferrari et al., 2014*).

As regard radiological assessment, several methods are used to quantify the diaphragmatic mobility using chest radiographs (*Singh et al., 2001*), computed tomography scan (*Cassart et al., 1997*), and dynamic magnetic resonance imaging (*Suga et al., 1999*). Radiological evaluation of diaphragm mobility has traditionally been performed through fluoroscopy (*Harris et al., 1983*).

Although fluoroscopy is considered the gold standard, it presents some limitations, such as diaphragm visualization with a single angle of incidence, requirement to perform corrective calculations and patient exposure to ionizing radiation (*Gierada et al., 1998*).

Over the past few years, ultrasound has also been used to evaluate diaphragmatic mobility, since it offers some advantages over fluoroscopy: portability; no exposure to ionizing radiation; and direct quantification of diaphragmatic movement (*Houston et al., 1995*).

Changes in intrathoracic pressures are transmitted to the heart and pericardium, the great arteries and veins. Spontaneous inspiration produces a negative pleural pressure; the reduction in intrathoracic pressure is transmitted to right atrium. In contrast, intermittent positive pressure ventilation (IPPV) produces inspiratory increase in intrathoracic pressures thereby increasing the right atrial (RA) pressures and if positive end expiratory pressure (PEEP) is added, these pressures will remain greater than atmospheric pressure throughout the respiratory cycle. Major compromise in cardiac output by impeding venous return may be seen in cases of septic shock and hypovolemia. (*Amiel et al., 2010*).

Secondly, venous return is concomitantly reduced through increased intrathoracic pressure. By contrast, increasing PEEP during volume-controlled mechanical ventilation leads to respiration-phase-specific reduction in RV output, especially pronounced during the inspiratory phase (*Schmitt et al., 2001*).