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

Thesis

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By

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Contents

List of Abbreviations

A-P **:** Antero-posterior

AR : Aortic regurgitation

AS : Assessing aortic stenosis

AV **:** Aortic valve

BIPAP : Dual-pressure ventilation

RVSP : Right ventricular systolic pressure

RAP **:** Right atrial pressure

CBC : Complete blood count

CO : Cardiac output

COPD : Chronic obstructive pulmonary disease

CVP **:** Central venous pressure

SIMV **:** Synchronized intermittent mandatory ventilation

CPAP : Continuous positive airway pressure

CW : Continuous wave Doppler

DE : Diaphragmatic excursion

DH : Dynamic hyperinflation

ECG : Electrocardiograph

FiO2 : Fraction of inspired oxygen

ICU : Intensive care units

IGF-1 : Insulin-like growth factor 1

IMP : Inosine monophosphate

IMV : Invasive mechanical ventilation

IPPV : Intermittent positive pressure ventilation

IVC : Inferior vena cava

LA : Left atrial

LVEF : Left ventricular ejection fraction

MAX : Maximal expiratory pressure

MV : Mitral valve

NIV : Noninvasive ventilation

NO : Nitric oxide

OTI : Orotracheal intubation

PaCO2 : Arterial carbon dioxide pressure

P_{AW} : Airway pressure

PCO2 : Partial pressure of carbon dioxide

PEEP : Positive end expiratory pressure

PH : Pulmonary hypertension

PSV : Pressure support ventilation

PVR : Pulmonary vascular resistance

PW : Pulsed-wave Doppler

RA : Right atrial

ROI : Reactive oxygen intermediates

RV : Right ventricle

SBT : Spontaneous breathing trial

SID : Strong ion difference

sPAP : Systolic pulmonary arterial pressure

SVC : Superior vena caval

TAPSE : Tricuspid annular plane systolic excursion

TF : Thickening fraction

TR **:** Tricuspid regurge

TV : Tricuspid valve

VC **:** volume control

VE : Minute ventilation

$\mathbf{V_T}$: Tidal volume

2D : Two-dimensional

List of Figures

List of Tables

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).***