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[ORIGINAL ARTICLE]

Evaluation of Recovery of Oxygen Saturation and Rate of Perceived Exertion in Different Body Positions after Submaximal Exercise test in Normal Healthy Individual.

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Introduction –

Oxygen saturation is that the fraction of oxygen saturated hemoglobin relative to total hemoglobin within the blood. The human body requires and regulates a precise and specific balance of oxygen within the blood. Normal oxygen saturation levels in humans are 95-100 percent. If abnormal rate of respiration or bluish colour change is present, it becomes very important to monitor oxygen saturation with a pulse oximeter. When oxygen saturation drops below 95%, it is considered as hypoxic state.[1]

Changes in an exceedingly patient's body position help in reducing pressure, increasing patient comfort, and helping to facilitate pulmonary secretion.[2] Optimal transportation of blood and oxygen to the body tissues gets hampered when the patient stays in the same position for prolong period or if there is any change in the body position. Also, if patient is placed in correct position for optimal period, it contributes to improvement in gas exchange and recovery of the condition.[3]

Body positions can increase ventilation-perfusion ratios.4 The reason behind the impairment in lung function to carry out gas exchange is the imbalance between the ventilation and perfusion within the upper and lower lung areas.5 In patients who are very young or elder, obese, or severely ill, improper body position change can interrupt the oxygen transport.[6]

Breathlessness is an unpleasant sensation of rapid or difficult breathing. Its onset is also sudden (acute) or gradual, which develops over a long time (chronic).[7,8] The explanation behind the subject experiencing breathlessness is that the body demands more oxygen than it supplies.[7,8]

As a results of which the brain sends signals of breathing faster to enhance the flow of oxygen-rich air into the lungs via which the oxygen gets into the bloodstream and is pumped around to the body via the aorta of heart.[7-9]

A normal healthy individual breathes in and out up to twenty times a minute, which accounts for nearly 30,000 breaths a day.10 An active exercise or an exertional session of work may throw a kink in that pattern due to breathlessness since the lungs don't supply the increasing demand for oxygen to the body via the heart. This is termed as exercise-induced breathlessness.[7-10]

Rate of perceived exertion measured by using MBS. Borg scale rating is from 0-10 grade.

A patient is continually exposed to gravity, thus every position the patient assumes reflects the effect of gravity on oxygen transport, thus, oxygen transport is often improved, maintained, or worsened with changes in body position. Despite being essential to normal cardiopulmonary function, gravity is that the principal contributor to significant inhomogeneity of physiological function down the lungs.[11]

When upright, the diameter of the most airways increase slightly. If the airways are obstructed even small degrees of airway narrowing induced by recumbency may result in significant airway resistance. The vertical gravitational gradient is maximal when upright, the anteroposterior dimension of the chest wall is that the greatest, and compression of the heart and lungs is minimal.12 The shortened position of the diaphragmatic fibers is countered by a rise in the neural drive to respire in the

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upright position.[13]

The supine position is not physiological position for humans unless sleeping, and this position is physiologically the least justifiable position for ill patients irrespective of whether they exhibit cardiopulmonary dysfunction.[14-17]

The supine position alters the chest wall configuration, the anteroposterior position of the hemidiaphragm, the intrathoracic pressure, and therefore the intraabdominal pressure secondary to the shifting of the abdominal viscera during this position.[18-24]

Because of the reduction in vertical gravitational gradient, and therefore the intrapleural pressure gradient of the lung in supine, the distribution of V/Q matching appears more uniform and evenly matched within the supine position.[25]

The prone position improves the arterial oxygenation and reduces the work of inhalation in patients with cardiopulmonary dysfunction. Arterial oxygen tension, tidal volume and lung compliance can be improved in prone position.[26-28]

Submaximal exercise tests may be used to predicts aerobic capacity or to assess the flexibility to perform the same exercise or task. Additionally, measurements taken before, during, and after the test can yield valuable information regarding the person's exercise response.

Material and Methodology:

This was an observational study with a study duration of 6 months. A total of 40 participants were recruited using the purposive sampling method from Dr. Vitthalrao Vikhe Patil College of Physiotherapy, Ahmednagar. The study materials included Weighing Machine, Measuring Tape, Stepper, Pulse Oximeter, MBS, Metronome.

The inclusion criteria included healthy students with age 18-25, both male and female, healthy students with normal Body Mass Index. (18.5 – 24.9), healthy students with normal Chest-Xray findings, healthy students with normal breath sounds on auscultation. While the exclusion criteria included students with BMI > 24.9 and < 18.5, students diagnosed with respiratory problem, students with high blood pressure (SBP>180mm Hg (DBP>100mm Hg), Resting heart rate >120/ min (Tachycardia), Recent fracture, Smokers, Unstable Angina, Myocardial infarction during previous month.

Procedure:

Institutional Ethical Committee approval was obtained before the commencement of the study. Healthy students were selected based on inclusion and exclusion criteria. Informed consent was obtained prior to involving them in the study in a language best understood by them. Basic demographic data like name, age, gender, weight, height, BMI, smoking history was documented on data collection sheet. The subjects were explained about the procedure, benefits, and the need of the study in a language best understood by them. Check vitals and RPE in sitting position ask the subject to perform the submaximal exercise test after that place subject in supine/ prone / upright sitting on alternate day and records the SPO2 by pulse oximeter and RPE by MBS Immediately, at 1min, at 3 min, at 5 min. Compare the recovery of oxygen saturation and RPE in three positions.

Procedure of submaximal exercise test (Queens college step test)

The queen college step test is one of many variations of step test procedures used to determine aerobic fitness.

Purpose- This submaximal test provides a measure of cardiorespiratory or endurance fitness.

Equipment required- 16.25 inches / 41.3 cm step, stopwatch, metronome or cadence tape, pulse oximeter.

Procedure- The subject steps up and down on the platform at a rate of 22 steps per min for females and at least 24 steps per min for male. The subjects are to step using four-step cadence, "up-up-down-down" for 3 minutes (Fig-1).



Fig-1: Subject performing submaximal step test i.e.: 3 min step test



Fig-2: SpO2 and RPE measured in prone position



Fig-3: SpO2 and RPE measured in supine position



Fig-4: SpO2 and RPE measured in upright sitting position

Results:

Table no. 1 shows Recovery of oxygen saturation at different body positions.

Body Position	SPO2 (Mean ±SD)			
	Pre-test	Immediate	At 1 min	At 3 min
Supine	99	95.80±2.6	97.65±1.4	99±
Prone	99	96.15±2.3	99±0.9	-
Upright sitting	99	95.63±2.5	97.48±1.1	99±

In Supine position recovery occurs at 3 min (Fig-3).

In Prone position recovery occurs at 1 min (Fig-2).

In upright position recovery occurs at 3 min (Fig-4).

This shows that fastest recovery occurs in prone position that is within 1 min (99±0.96) than supine within 3 min (99±0) than upright sitting within 3 min (99±0).

Table no. 2 shows Recovery of Rate of perceived exertion at different body positions.

Body Position	RPE (Mean ± SD)			
	Pre-test	Immediate	At 1 min	At 3 min
Supine	0±0	3.23±1.44	1.52±1.09	0±0
Prone	0±0	2.93±1.11	0.825±0.99	0±0
Upright sitting	0±0	3.40±1.29	1.73±0.89	0±0

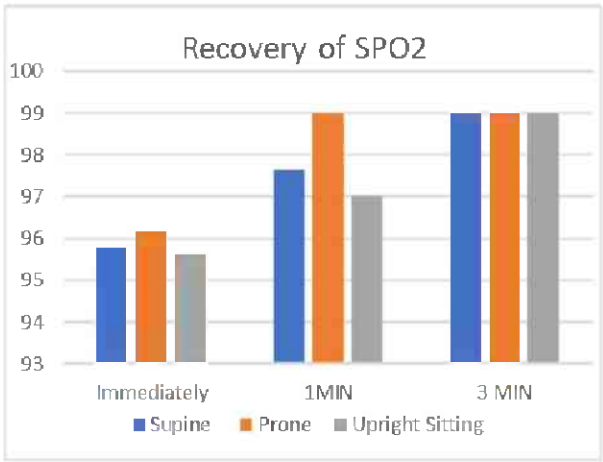
In Supine position recovery occurs at 3 min.

In Prone position recovery occurs at 1 min.

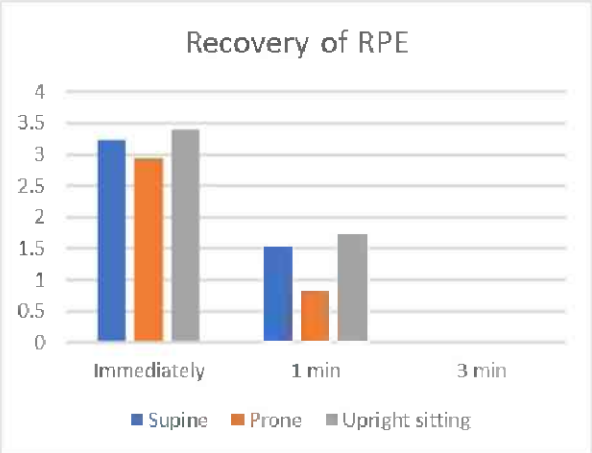
In upright position recovery occurs at 3 min.

This shows that fastest recovery occurs in prone position that is within 1 min (0.825±0.99) than supine within 3 min (0±0) than upright sitting within 3 min (0±0).

Graphical Presentation:



Graph-1: Showing recovery of SpO2 in supine, prone & upright sitting position



Graph-2: Showing recovery of RPE in supine, prone & upright sitting position

Discussion:

The present study was conducted on Evaluation of Recovery of oxygen saturation and Recovery of Rate of perceived exertion in different body positions after submaximal exercise test in normal healthy individual. The oxygen saturation was measured in the three different positions in the present study that is supine prone and upright sitting position and the dyspnoea rate that is rate of perceived exertion in the same 3 different position.

From the current study it is stated that the oxygen saturation recovery is fastest in prone position as compared to supine and upright sitting as shown in table no. 1 and the same is that for the rate of perceived exertion i.e., the recovery for dyspnoea was greater and fastest in prone as compared to supine and upright sitting as shown in table no.[2]

As shown in table no.1 the mean value for oxygen saturation in prone position is (99±0.96) and the comparison between three different position is considered very significant (p value 0.02). and the mean value for RPE in prone is (0.825±0.99) and the comparison between three different position is extremely significant (p value 0.001).

The mean value for oxygen saturation in prone position is (99±0.96) statistically higher as compared to other position as the prone positioning causes the diaphragm capacity to expand i.e., increased compliance. Accordingly, the chest wall obtained a uniform movement, and the ventilation is distributed well thus resulting in increased balance of the perfusion ventilation which directly increases the oxygenation. The prone position also increases oxygenation through the end expiratory volume increase mechanism and correct the occurrence of venous stasis. Moreover, prone positioning may reduce the occurrence of gastroesophageal reflux. The prone position is practiced enhancing the arterial oxygenation and reduce the work of breathing in patients with cardiopulmonary dysfunction as it improves arterial oxygen tension, tidal volume, and lung compliance.

This result is consistent with the study conducted by the author Mancebo et.al in 2006 found that the prone position has a positive effect by increasing and maintaining the oxygen saturation within normal limit at 95-100%.

Burcu Ceylan et.al in 2016 conducted a study which measured the mean oxygen saturation value in supine position and in prone position. The study concluded that, mean oxygen saturation was significantly higher in prone position than in supine position.

The study conducted by the Smith et.al in 2010 on healthy individual. In conclusion no significant statistical difference was recorded in oxygen saturation values which was assessed in two different body position i.e., supine, and semi-fowlers and these values were within the normal range.

In a study carried out by Jones & Dean in 2004 with healthy individuals, no difference was found between oxygen saturation values in different positions.

The mean value for rate of perceived exertion is (0.825±0.99) in prone position is statistically higher as compared to other position. Because of higher density of pulmonary vessels in dorsal lung region the change of ventilation distribution while prone results in improved V/Q matching and oxygenation and as the oxygenation is improved, breathlessness is reduced.

In the study conducted by the Iren Telis et al it was reported that the contraction of the muscular diaphragm which faces the open dorsal lung during pronation exerts a more uniform distribution of stress, whereas the muscular diaphragm exerts a more localised stress when facing collapsed lung during supination.

Conclusion:

From the present study we evaluate the Recovery of oxygen saturation and RPE in supine, prone, upright sitting position and we found that the fastest recovery of oxygen saturation and Rate of perceived exertion occurs in prone position than supine and upright

sitting position after submaximal exercise testing in normal healthy individual.

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