Effect of Body Position on Oxygenation and Hemodynamic Status among Patients with Traumatic Brain Injury

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ABSTRACT

Context: Positioning is one of the most frequently performed nursing activities in the critical care unit. It is often providing a central pivotal focus for planning other nursing activities. Therapeutic positioning of the patient's head, different degrees of the head of the bed elevation has been suggested as a low-cost and simple approach to preventing secondary brain injury.

Aim: determine the effect of body position on oxygenation and hemodynamic status among patients with traumatic brain injury.

Methods: Quasi-experiments (single group pre/posttest design). The study was conducted in the Critical Care Units in El-Mansoura general hospital at El-Mansoura city. A purposive sample of (67) adult patients diagnosed with traumatic brain injuries was recruited in this study. A structured socio-demographic interview questionnaire, patients' medical records to elicit clinical variables and record cardiorespiratory assessment findings, Glasgow Coma Scale, and Richmond Agitation Sedation Scale were used to either include or exclude the patient according to the study criteria.

Results: There was a significant increase in oxygen saturation in post right lateral position from (94.93 ± 1.25 to 95.37 ± 1.17) and the semi fowler position from (95.37 ± 1.17 to 97.31 ± 11.13) compared to pre-positioning. The hemodynamic parameters (heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure) were significantly decreased in the post-semi-fowler position and then right lateral position compared to pre. Besides, the CVP is significantly increased in the semi-fowler position.

Conclusion: Oxygen saturation and all hemodynamic parameters were significantly improved compared to their normal range in post-semi-fowler position, then right lateral position. Develop nursing practice protocol for critical care nurses to position patients at the semi-fowler position after traumatic brain injury can improve oxygenation and hemodynamic parameters. Moreover, further studies should be carried out to assess the effect of other body positions in other medical conditions.

Keywords: Body position, oxygenation, hemodynamic status, traumatic brain injury

1. Introduction

In a recent study, sixty-nine million individuals are estimated to suffer Traumatic Brain Injury (TBI) from all causes each year, with the Southeast Asian and Western Pacific regions experiencing the greatest overall burden of disease. Head injury following road traffic collision is more common in low- and middle-income countries and the proportion of TBIs secondary to road traffic collision is likewise greatest in these countries. Meanwhile, the estimated incidence of TBI is highest in regions with higher-quality data, specifically in North America and Europe *(Dewan et al., 2018).*

Traumatic brain injury (TBI) is a significant public health problem and a fundamental cause of morbidity and mortality worldwide. Intracranial hypertension is the most common cause of disability and death in brain-injured people. Specific interventions in the intensive care unit are needed to minimize secondary brain injury after trauma. Therapeutic positioning of the head at different degrees of the head of bed elevation (HBE) has been recommended as a low-cost and simple way of preventing secondary brain injury in these patients *(Alarcon et al., 2017).*

Positioning is one of the most common nursing activities performed in the critical care unit. It is often providing a central focus that directs other nursing activities. Recently, the concept of therapeutic positioning is emerging in trauma and critical care with the adaptation of research-based positioning strategies designed to enhance or promote physiologic stability and tolerance of nursing and medical treatments. Therapeutic positioning is a core component of critical care nursing to optimize ventilation and perfusion and promote effective pulmonary gas exchange *(Anchala, 2016).*

Rising from the supine to upright position results in changes in the cardiovascular system such as decreased Mean Arterial Pressure (MAP), and every 2.5 cm change of vertical height from the reference point at the heart level leads to a change of MAP by two mmHg either decrease or increase in the opposite direction, decreased Central Venous Pressure (CVP) slightly (3mm Hg), impaired venous return from reduced stroke volume by 40% with massive venous pooling in the lower extremities leading to decreased cardiac output by 25% and increased total peripheral resistance by 25%, systolic blood pressure is

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slightly decreased due to falling in stroke volume, diastolic blood pressure is slightly elevated due to increased total peripheral resistance, and heart rate is increased by 25% *(Khurana & Khurana, 2015).*

Hemodynamic instability is the foremost reason for staying the critically ill patients in the supine position for prolonged periods. The cardiovascular system attempts to adapt in two ways after a change in the body's gravitational plane: The autonomic nervous system can receive messages from the shift in plasma volume to adjust the vascular tone. The cardiovascular system is affected by an inner ear or vestibular response *(Anchala, 2016)*

Turning and positioning critically ill patients in the intensive care unit (ICU) are well-accepted activities, with the primary purpose being to relieve pressure, improve patients' comfort, and aid pulmonary secretion. However, body positioning of critically ill patients may profoundly affect arterial oxygenation, which is reflected by the oxygen saturation (SpO_2) level in blood. The literature supports the benefits of regular body position changes, particularly for a relatively immobile, unalert, severely debilitated patient, breathing at low lung volumes, obese, aged or very young, or has lost the sigh mechanism. The practice of routinely turning patients every 2hr is an accepted standard of care *(Frownfelter & Dean, 2012)*

The semi-fowler position maximizes lung volumes and flow rate. Additionally, tidal volume increases due to the lowering of the diaphragm and increase alveolar expansion. Furthermore, the pressure on the diaphragm exerted by abdominal contents is decreased, increasing respiratory system compliance, so oxygenation increased, and $PaCO_2$ decreased *(Okasha et al., 2013).*

Researchers have not identified the head of the bed's optimal position, but it seems that positioning depends on the individual patient's condition. Recent studies have suggested that positioning the head of the bed can increase cerebral blood flow and maximize cerebral tissue oxygenation. A study using transcranial Doppler technology found that the head-flat position maximized blood flow to the brain *(Woodruff, 2016)*

2. Significance of the Study

Trauma strikes down the youngest and potentially most productive members of the community, and in a preliminary report, Egypt ranked highest in road fatalities globally, claiming 6000 lives per year in Egypt roads. Egypt recorded 11,098 traffic accidents in 2017, marking a 24.6 percent decrease, compared to 14,710 accidents in 2016. Those accidents resulted in the death of 3,747 people, the injury of 13,998, and the damage of 17,201 vehicles, according to the 2017 report released by the Central Agency for Public Mobilization and Statistics *(CAPMAS, 2018).* Awkwardly, there is no national registry for types of trauma.

Positioning is not only of importance for the comfort and well-being of bedridden people. Patient positioning is also an important part of the healing and preventive measures. There are many situations in which patient positioning should be an area of great attention. Particularly for long-term bedridden patients, patients with reduced mobility and major trauma, especially those suffering from traumatic brain injury, patients who receive hygiene procedures in bed, and unstable and restless patients. It is very important to evaluate the impact of body position on oxygenation and hemodynamic status, especially with critically ill patients with Traumatic Brain Injury (TBI).

3. Aim of the study

This study aimed to determine the effect of body position on oxygenation and hemodynamic status among patients with traumatic brain injury.

- Evaluate the effect of different body positions on oxygenation status.
- Determine the effect of changing body position on hemodynamic status.
- Determine the most effective position providing the best oxygenation status and hemodynamic stability.

4.Subjects & Methods

4.1. Research design

A quasi-experimental design (pre/post measurement) was utilized for the conduction of this study. This type of design was developed to control as many threats to validity as possible in a situation where some of the components of true experimental design are lacking. Most studies with quasi-experimental designs have samples that were not selected randomly, and there is less control of the study intervention, extraneous variables, and setting *(Grove et al., 2015).*

4.2. Research Setting

This study was conducted at Critical Care Units in El-Mansoura general hospital at El-Mansoura city. It is a big public central hospital that serves all EL-Daquahlya governorate centers, receives emergency cases three days a week, and includes (400) beds. The general Critical Care Unit consists of (16 beds). The unit receives about (225) patients with various diagnoses such as traumatic brain injuries (TBI), spinal cord injury, brain tumor, and spontaneous cerebral hemorrhage for preoperative, postoperative, and conservative management.

4.3. Subjects

Study subjects include a purposive sample of total TBI patients hospitalized during the year 2017. Their total number is 225 TBI patients. Based on the sample size equation (67), equivalent to (30%), TBI participated in the study. So, the sample size was calculated by adjusting the power of the test to 80%, and the confidence interval to 95% with a margin of error accepted adjusted to 5% and a known total population of (225) TBI patients using the following equation:

X = Z(c/100)2r(100-r)

N = Nx/((N-1)E2+x)

E = Sqrt [(N-n)x/n(N-1)]

N is the population size, r is the fraction of responses, and

Z(c/100) is the critical value for the confidence level *(Chow et al., 2007).*

Inclusion criteria

Adult male and female patients aged from 19 to 65 were diagnosed as having traumatic brain injuries with GCS between (3 to 14) and excluded about (158) patients with the following exclusion criteria.

Exclusion criteria

- Traumatic chest problem (pneumothorax, hemothorax, empyema, pleural effusion).
- Vertebral column fracture with spinal cord injury.
- Fractures of the pelvis, spine, shoulder girdle, ribs, or long bones because of mobility restriction and the possibility of harm for the patient.
- Hemodynamically unstable patient (such as severely hypertensive, acute myocardial infarction, acute respiratory distress syndrome, and unstable angina).
- Any patients complained of pain or discomfort while positioning or if the patient becomes hemodynamically unstable during changing of position or any position.
- Body mass index of more than 30 kg/m².
- Patients with fever (Temperature of more than 38 degrees).
- Agitated patients equal to 2 or greater on Richmond Agitation Sedation Scale (RASS) because agitation affects hemodynamic stability, and it is difficult to turn the agitated patients.

Sampling technique

Direct observation and reviewing the medical/nursing records were utilized to fill out demographic and medical-related data. The investigator applied positions' change on the participant (patients) directly from position to position throughout four positions (left lateral position, supine position, right lateral position, and semi-fowler position) each one hour. Also, direct observation was utilized (pre-positions measurements/post-positions measurements) to collect data about the patients' physiological response to body positions.

4.4. Tools of the study

Four tools were used to collect the data as follows:

4.4.1. Structured Interview Questionnaire

It developed by the researcher to assess socio-demographic characteristic for patients with traumatic brain injury such as (age, gender, education, occupation, and marital status)

4.4.2. Patients Medical Record

It consists of two parts

Part one consists of the patient's medical data such as duration of ICU stay, oxygen devices used, body mass index (BMI), current medical diagnosis, general medical history and surgical history, and medication. A standardized estimate of an individual's relative body fat is calculated from height and weight. The investigator developed this part.

Part two included the cardiorespiratory assessment record. It was developed by *Holzheimer and Mannick (2001)* to assess physiological parameters such as; Heart Rate (HR), Respiratory Rate (RR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), Central Venous Pressure (CVP). In addition to oxygen saturation level by a pulse oximeter. It was used twice at the start and the end of each position. These parameters were assessed in the following positions (semi-fowler, supine, right side laying, and left side laying position).

All physiological parameters and oxygenation were assessed according to reference range (Heart Rate: 60-100 b/m, Respiratory Rate: 12-18 C/m, Systolic Blood Pressure: 90-140 mmHg, Diastolic Blood Pressure: 60-90 mmHg, Mean Arterial Pressure: 70-105mmHg, Central Venous Pressure: 5-15 H_2O, oxygen saturation: 95-100%) *(Holzheimer & Mannick, 2001)*.

4.4.3 Glasgow Coma Scale (GCS)

Glasgow Coma Scale (GCS) is a neurological assessment scale developed by *Teasdale and Jennett (1974) and revised by Teasdale and Jennett (1976).* It is used to give a reliable and objective way of recording the conscious status of a person for initial and subsequent assessment. Patients were assessed against the criteria of the scale, and the resulting points give a patient score. This tool was used to determine the patients' level of consciousness to guide their inclusion of patients within the study sample.

Glasgow coma scale (GCS) content; Eye-Opening best: spontaneous (4), to speech (3), to pain (2), and none (1). best verbal response: oriented (5), confused conversation (4), inappropriate words (3), incomprehensible sounds (2), and none (1). Best motor response: Obeys commands (6), localizes pain (5), withdrawal (4), abnormal flexion "decorticate" (3), extension "decerebrate" (2), and none (1).

Scoring system of Glasgow coma scale for head injury patients.

The total score of (15) points classified as patients who open their eyes spontaneously, obey commands, and are oriented score a total of (15) points, the best possible score, whereas flaccid patients, who neither open their eyes nor verbalize, scored the minimum of (3) points. A GCS score of (8) or less is the generally accepted definition of coma. Those with a GCS of (8 or less) are classified as severe, while those with a GCS score of (9 to 12) are categorized as moderate, and those with a GCS score of (13 to 15) are mild *(Rabiu, 2011).*

4.4.4. Richmond Agitation Sedation Scale (RASS)

Richmond Agitation Sedation Scale (RASS) is the sedation scale used to monitor serial changes in a patient's mental status. It was used in this study to exclude patients whose score was two or more from the study sample.

The RASS scoring system

"Score +4" Combative (Overtly combative, violent, immediate danger to staff). "score +3" Very agitated (Pulls or removes tube(s) or catheter(s); aggressive). "score +2"

Agitated (Frequent non-purposeful movement, fights ventilator); "Score +1" Restless (Anxious but movements not aggressive vigorous). "Score 0" Alert and calm. (Spontaneously pays attention to caregiver).

A "score –1" Drowsy (Not fully alert but has sustained awakening to verbal stimuli (eye-opening/eye contact) to voice/verbal stimuli (>10 sec). "score –2" Light sedation (Briefly awakens with eye contact to voice/verbal stimuli (<10 sec)). "Score –3" Moderate sedation (Movement or eye-opening to voice/verbal stimuli (but no eye contact) "score –4" Deep sedation (No response to voice, but movement or eye-opening to physical stimulation). "Score –5" Unarousable (No response to voice or physical stimulation). The RASS was Scored as four possible degrees for progressive agitation from (+1) to (+4) and five possible degrees for progressive sedation from (-1) to (-5). The optimal RASS score is zero (alert and calm) *(Sessler et al., 2002).*

4.5. Procedures

Official permission to carry out the study submitted from the Dean of the Faculty of Nursing, Ain Shams University, issued to the director of Critical Care Units in El-Mansoura general hospital at El-Mansoura city to access sample subjects and starting the data collection process. The aim of the study and its procedures were included in the letter.

Verbal consent was taken from patients or responsible relative to participate in the study after explanation of the study aim, the participants in the study were informed that they have the right to withdraw from the study at any time without penalties, and the participants were assured about confidentiality and anonymity of information gathered and would be used only for the study.

The current study was carried out in two phases, the designing and implementation phases.

Designing phase: The designing phase was concerned with constructing and preparing the study tools, which were made after an extensive review of literature, relevant studies, research articles, website searches, and seeking expert advice. The researcher constructs the study tools that are revised by a panel of seven medical and critical care nursing experts for testing the tools' content validity then piloted on 10 percent of the study sample of patients in the general Critical Care Unit in El-Mansoura general hospital to ensure clarity, objectivity, and relevance of the study tools and to test the feasibility of the research process to establish the content and face validity of these tools.

Based on the result of the pilot study, no modifications were done. Then, 10 percent of the patients were included in the actual study. Cronbach's alpha for (GCS), (RASS) was (0.87, 0.82) while the internal consistency of the cardiorespiratory assessment record has been tested using Cronbach's alpha coefficient was (0.77).

Implementation phase: Data were collected over six months from the beginning of August 2019 to the end of January 2020. Data were collected for three days a week from Wednesday to Friday (morning shift from 8:00 am to 2:00 pm), (afternoon shifts from 2:00 pm to 8:00 pm), and (night shift from 8:00 pm to 8:00 am). Once permissions were granted, all the patients who fulfilled the inclusion criteria were recruited into the present study.

The investigator visited the general Critical Care Unit in El-Mansoura general hospital; at the beginning of the visit, the researcher collected patients' demographic data from the patient's using the structured interview questionnaire and reviewing the medical and nursing records to identify the patients who matched the inclusion criteria. Then verbal consents were obtained from each participant (conscious patients) or responsible relative for unconscious patients to be included in the study after explaining, clarification of the nature and purpose of the study.

The investigator assessed the conscious level by using the Glasgow coma scale (GCS) for every participant and (RASS) to detect the agitation level of the patients. Body mass index was calculated for all adult traumatic brain injury patients who fulfilled the inclusion criteria; those with a BMI of less than 30 kg/m^2 were included in the study. BMI of the patients was obtained by measuring the weight and the height of the patients. Some beds have a weight scale for patients, and the others were estimated in addition to height was measured in bed. The body mass index is scored as; underweight (less than 18.5), normal weight (18.5-24.9), overweight (25-29.9), obesity (BMI of 30 or greater) *(Jensen, 2011).*

Each participant was examined in four positions (left side position, supine position, right side position, and semi-fowler position). The investigator changed positions and took a single measure to oxygenation and hemodynamic parameters to describe the effect of positions on oxygenation and hemodynamic stability. A pulse oximeter used to read the Oxygen level and hemodynamic parameters such as; Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) were measured by sphygmomanometer manually by the investigator.

Also, Heart Rate (HR), Respiratory Rate (RR), Mean Arterial Pressure (MAP), Central Venous Pressure (CVP) assessed via the bedside monitor (Nihon Kohden Life Scope Bsm-3500), which was calibrated automatically. All parameters were measured at the start of one hour of each position as a pre-measure and the end of the hour of each position as post measure. No nursing activities were done during the positioning, so it will not affect the studied variables.

The all-time needed for the application of the tool lasted approximately about four to five hours to apply all four positions for all patients at the same visit. An approximate number of patients diagnosed with traumatic brain injuries fulfilled with study criteria in the ICU at El-Mansoura general hospital was about seven to ten patients per visit. The researcher measured parameters for all available patients with a predetermined inclusion and exclusion criteria at the same time each visit.

4.6. Data analysis

Upon completion of the data collection, data were tabulated and analyzed using SPSS program version 25. Relevant statistical analysis was used to test the obtained data. Descriptive statistics were applied (e.g., mean, standard deviation, frequency, percentage). Also, paired t-test was used to compare pre-measures and post-measures in every one of the four positions for all parameters. The level of significance is determined at $p \leq 0.05$ and a highly statistically significant difference at ≤ 0.001.

5. Results

Table 1 indicates the frequency and percentage distribution of patients with traumatic brain injury demographic characteristics (n= 67). It reveals that 56.7% of the studied patients were in the age group of 19-30 years with a mean age of (33.43 ± 10.58), 94% were males, 34.3% and 38.8% had either secondary or university education, 52.2% were workers, and 32.8% were employees. Besides, 73.1% were married.

Table 2 describes the frequency and percentage distribution of the clinical data among patients with Traumatic Brain Injury. It shows that 47.8% of patients stayed in the intensive care unit for more than six days, with a mean length of stay (6.85 ± 3.69). More than half (53.7%) of the studied subjects were mechanically ventilated, and 62.7% of their body mass index was ranged between 18.5-24.9 Kg/m^2 (normal weight) with a mean (23.48 ± 2.53).

Regarding diagnosis, 28.35% had brain contusion and skull fracture, 22.38% Subdural hemorrhage (SDH) & Subarachnoid hemorrhage (SAH). Also, 100% of patients received antibiotics, antiepileptic, and IV fluids with no surgical history. In addition to 41.8% of the sample were in a severe coma, and 41.8% were in a mild coma. Besides, Regarding RASS, 44.8% of the sample were deeply sedated and unarousable.

Table 3 compares oxygenation and hemodynamic parameters between the pre-position and post-position in the left lateral position (LLP). It reveals that oxygen saturation shows a highly significant reduction post left lateral position compared to pre-position. Also, hemodynamic parameters (HR, SBP, DBP, MAP, and CVP) showed a highly statistically significant increase in the mean scores of post-positions in the left lateral position compared to pre-position, while RR is increased post-LLP compared to pre, but it did not reach the significant level.

Table 4 compares oxygenation and hemodynamic parameters between the pre-position and post-position in the supine position (SP). Analysis revealed that Oxygen saturation shows a highly significant reduction post SP compared to pre-position, while all hemodynamic parameters (HR, RR, SBP, DBP, MAP, and CVP) shows a highly statistically significant increase in the mean scores of supine post position compared to pre-position at $p<0.001$.

Table 5 compares oxygenation and hemodynamic parameters between the pre-position and post-position in the right lateral position (RLP). It shows a statistically significant difference between pre-and post-right lateral positioning (RLP) regarding the oxygen saturation (as O2 saturation is significantly improved post-RLP compared to pre).

Also, a significant reduction in HR and RR was revealed. The systolic blood pressure shows a significant decrease post-RLP compare to pre-position level, with a reduction in diastolic pressure, but it did not reach the significant level. Mean arterial blood pressure shows a significant decrease, while CVP shows a significant increase.

Table 6 compares oxygenation and hemodynamic parameters between the pre-position and post-position in the semi-fowler position (SFP). It shows a non-significant increase between pre-and post-semi fowler position regarding the oxygen saturation (as O_2 saturation is improved post SFP compared to pre, but it did not reach the significant level). Also, (HR, RR, SBP, DBP, and MAP) show a highly significant reduction post-SFP compared to pre-position, while central venous pressure shows a significant increase in post-SFP compare to pre-position level at $p<0.001$.

Figure 1 shows that the best position (regards normal range: 95-100%) for best oxygen saturation is semi fowler position. The left lateral position is the second best, while the worst oxygenation was in the supine position followed by the right lateral position after one hour of positioning.

Figure 2 shows the best heart rate (regards normal range: 60-100b/m) was shown in semi-fowler position and left lateral position, while the supine position and right lateral position show elevated heart rate.

Figure 3 shows that the best respiratory rate related to (normal range: 12-18c/m) was shown in semi-fowler position (SFP) and left lateral position (LLP), while supine position (SP) and right lateral position (RLP) show elevated respiratory rate.

Figure 4 shows the best systolic blood pressure related to (normal range: 90-140 mmHg) was shown in semi-fowlers position (SFP) and left lateral position (LLP), while supine position (SP) and right lateral position (RLP) show elevated systolic blood pressure.

Figure 5 shows that the best diastolic blood pressure related to (normal range: 60-90 mmHg) was shown in semi fowler position (SFP) and left lateral position (LLP), while supine position (SP) and right lateral position (RLP) show elevated diastolic blood pressure.

Figure 6 shows that the best mean arterial pressure related to (normal range: 70-105 mmHg) was shown in semi fowlers position (SFP) and left lateral position (LLP), while supine position (SP) and right lateral position (RLP) show elevated mean arterial pressure.

Figure 7 shows that the highest central venous pressure related to (normal range: 5-15 H_2O) was shown in semi fowler position (SFP) (9.88) and right lateral position (RLP) (8.78), while the lowest CVP was shown in left lateral position (LLP) (5.82) and supine position (SP) (7.42).

Figure 8 shows that the best position for oxygenation and hemodynamic parameters was showed in the semi-fowler position (SFP) after one hour of positioning regarding the normal range in each parameter except for the CVP; all positions showed normal ranges of this parameter.

Table (1): Frequency and percentage distribution of patients with traumatic brain injury demographic characteristics (n= 67).

Demographic variables percent	No.	%
Age		
19-30	38	56.7
>30-41	16	23.9
>41-53	6	9.0
>53-64	7	10.4
Mean±SD	33.43±10.58	
Gender		
Male	63	94.0
Female	4	6.0
Education		
Literate	3	4.5
Read & write	15	22.4
Secondary school	23	34.3
University degree	26	38.8
Occupation		
Housewife	3	4.5
Retired	1	1.5
Worker	35	52.2
Employee	22	32.8
Student	3	4.5
Not work	3	4.5
Marital status		
Single	13	19.4
Married	49	73.1
Widow	4	6.0
Divorced	1	1.5

Table (2): Frequency and percentage distribution of the clinical data among Patients with Traumatic Brain Injury (N= 67).

clinical data percent	No.	%.
Duration of stay		
<3 days	9	13.4
3-6 days	26	38.8
More than six days	32	47.8
Mean ± SD	6.85±3.69	
O_2 therapy device used		
Room Air (RA)	10	14.9
Mask & nasal cannula	13	19.4
T- piece	8	11.9
Mechanical ventilation	36	53.7
Body Mass Index		
Underweight	2	3.0
Normal weight	42	62.7
Overweight	16	23.9
Obese	7	10.4
Mean ± SD	23.48±2.53	
Patients Diagnosis		
Subdural hemorrhage (SDH)	14	20.89
Subarachnoid hemorrhage (SAH)	9	13.43
SDH & SAH.	15	22.38
Epidural hemorrhage (EH)	4	5.97
Intraventricular hemorrhage (IVH) & (SAH)	6	8.95
Brain contusion and skull fracture.	19	28.35
General Medical history		
Yes	12	17.9
No	55	82.1
General surgical history		
Yes	0	0
No	67	100.0
Medication		
Antibiotic	67	100.0
Antiepileptic	67	100.0
Brain stimulant	19	28.3
IV Fluids	67	100.0
Sedation	44	65.6
GCS		
3-6	28	41.8
7-10	11	16.4
11-14	28	41.8
RASS		
Restless, alert and calm, and drowsy	22	32.8
Light, moderate sedation	15	22.4
Deep sedation, unarousable	30	44.8

Table (3): Comparison of oxygenation and hemodynamic parameters between the pre-position and post-position in left lateral position (LLP).

Cardiorespiratory Parameters	Pre	1 hour Post	Paired t-test	p-value
	Mean±SD	Mean±SD		
Oxygen saturation	97.45±1.29	96.6±1.45	5.947	<0.001
Heart rate	94.63±15.28	95.49±14.54	3.518	<0.001
Respiratory Rate	18.67±3.23	18.94±2.61	1.493	0.140
Systolic Blood Pressure	128.21±17.14	136.42±17.21	7.891	<0.001
Diastolic Blood Pressure	77.61±11.16	79.85±9.77	2.940	0.005
Mean Arterial Pressure	94.51±12.5	98.34±11.29	6.078	<0.001
Central Venous Pressure	4.06±1.74	5.82±1.65	20.646	<0.001

Table (4): Comparison of oxygenation and hemodynamic parameters between the pre-position and post-position in the supine position (SP).

Cardiorespiratory Parameters	Pre	1 hour Post	Paired t-test	p-value
	Mean±SD	Mean±SD		
Oxygen saturation	96.6±1.45	94.93±1.25	9.505	<0.001
Heart rate	95.49±14.54	98.34±14.94	8.390	<0.001
Respiratory Rate	18.94±2.61	20.55±3.06	10.043	<0.001
Systolic Blood Pressure	136.42±17.21	141.19±14.2	4.750	<0.001
Diastolic Blood Pressure	79.85±9.77	84.93±8.77	6.294	<0.001
Mean Arterial Pressure	98.34±11.29	103.72±10.17	8.703	<0.001
Central Venous Pressure	5.82±1.65	7.42±1.66	18.738	<0.001

Table (5): Comparison of oxygenation and hemodynamic parameters between the pre-position and post-position in right lateral position (RLP).

Cardiorespiratory Parameters	Pre	1 hour Post	Paired t-test	p-value
	Mean±SD	Mean±SD		
Oxygen saturation	94.93±1.25	95.37±1.17	2.459	0.017
Heart rate	98.34±14.94	97.28±14.62	3.178	0.002
Respiratory Rate	20.55±3.06	19.97±2.93	2.657	0.010
Systolic Blood Pressure	141.19±14.2	138.51±10.34	2.658	0.010
Diastolic Blood Pressure	84.93±8.77	83.28±6.37	1.624	0.109
Mean Arterial Pressure	103.72±10.17	101.66±7.1	2.292	0.025
Central Venous Pressure	7.42±1.66	8.78±1.44	12.850	<0.001

Table (6): Comparison of oxygenation and hemodynamic parameters between the pre-position and post-position in semi-fowler position (SFP).

Cardiorespiratory Parameters	Pre	1 hour Post	Paired t-test	p-value
	Mean ± SD	Mean ± SD		
Oxygen saturation	95.37±1.17	97.31±11.13	1.432	0.157
Heart rate	97.28±14.62	90.85±11.52	9.203	<0.001
Respiratory Rate	19.97±2.93	17.13±2.39	19.328	<0.001
Systolic Blood Pressure	138.51±10.34	130.75±8.04	12.288	<0.001
Diastolic Blood Pressure	83.28±6.37	77.01±5.78	7.184	<0.001
Mean Arterial Pressure	101.66±7.1	95.07±5.77	9.243	<0.001
Central Venous Pressure	8.78±1.44	9.88±1.39	8.762	<0.001

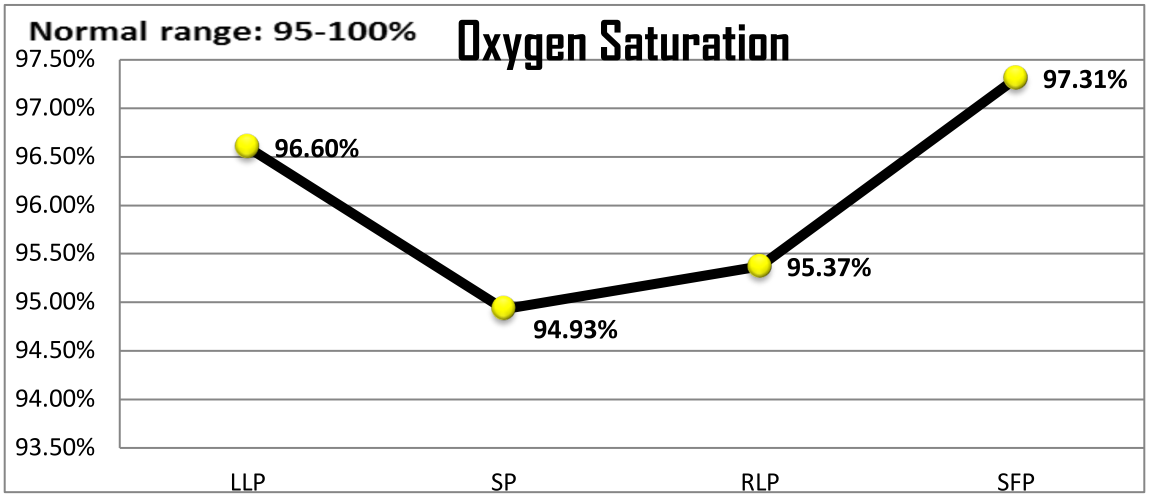


Figure (1): Comparison of oxygen saturation after one hour of positioning in different body positions.

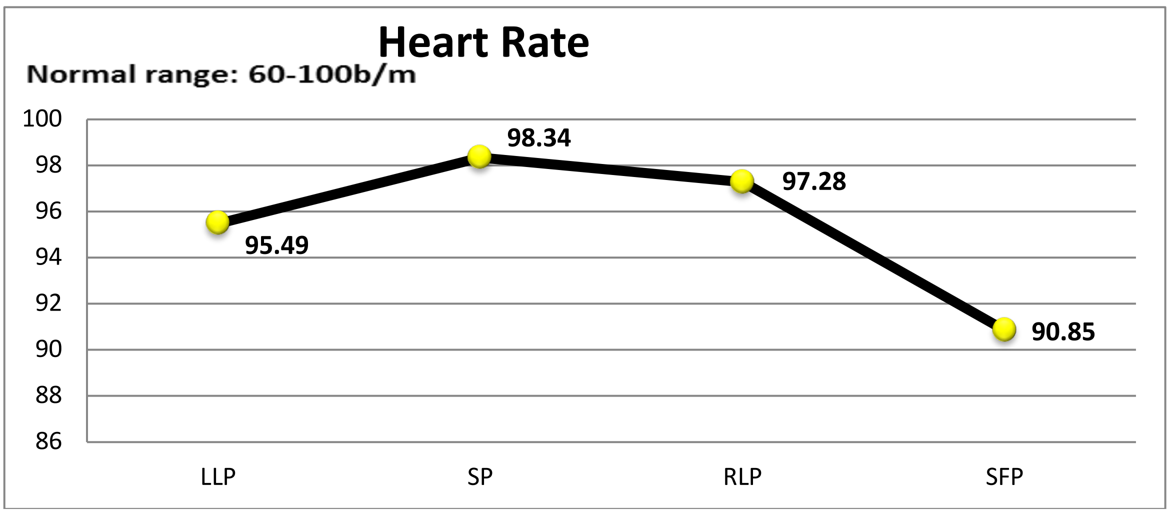


Figure (2): Comparison of heart rate (HR) after one hour of positioning in different body positions.

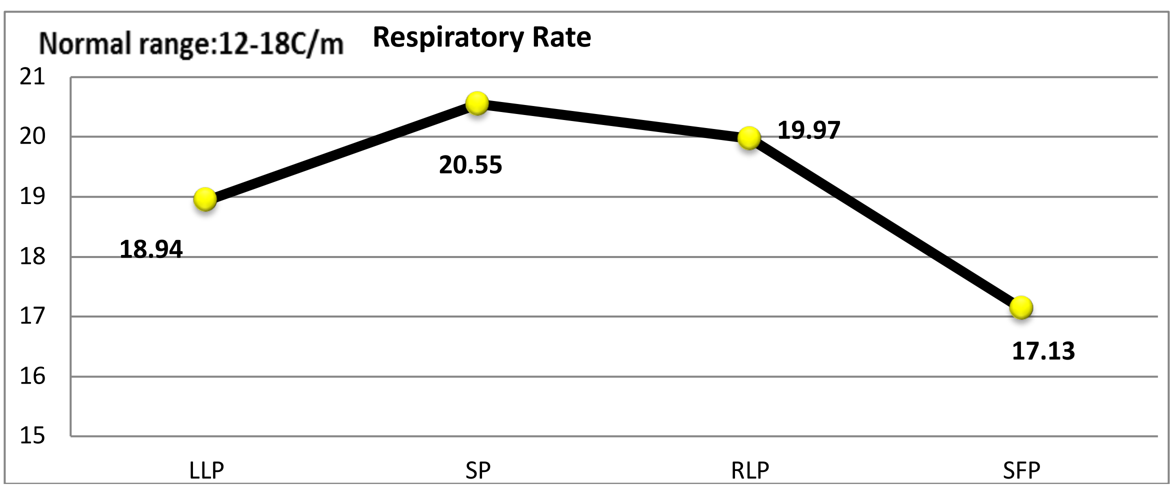


Figure (3): Comparison of respiratory rate (RR) after one hour of positioning in different body positions.

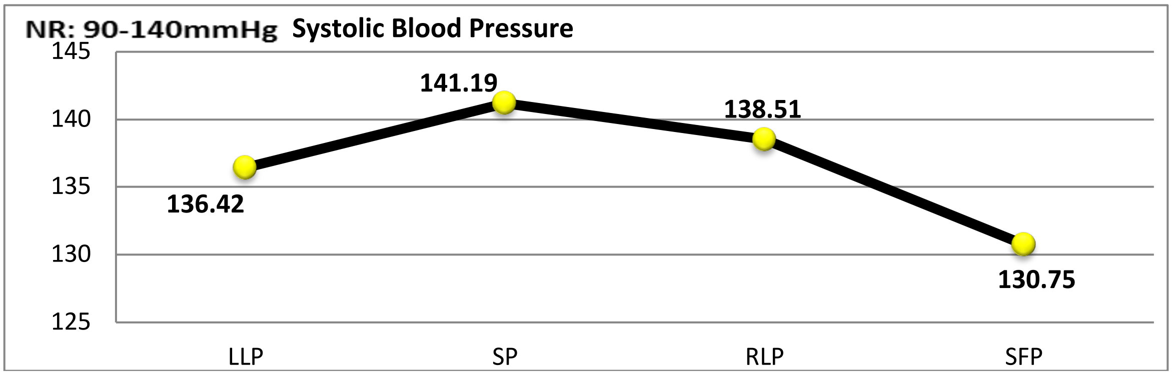


Figure (4): Comparison of systolic blood pressure (SBP) after one hour of positioning in different body positions.

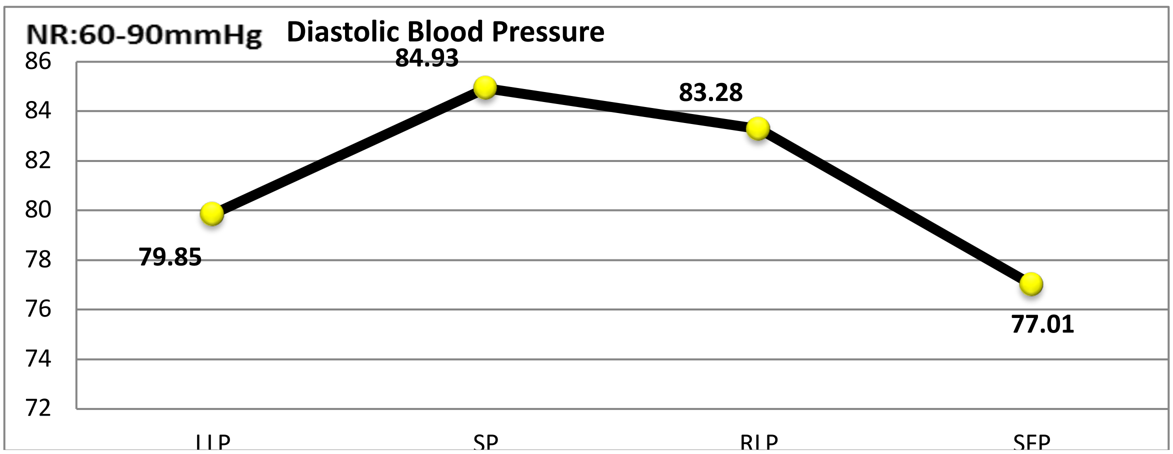


Figure (5): Comparison of diastolic blood pressure (DBP) after one hour of positioning in different body positions.

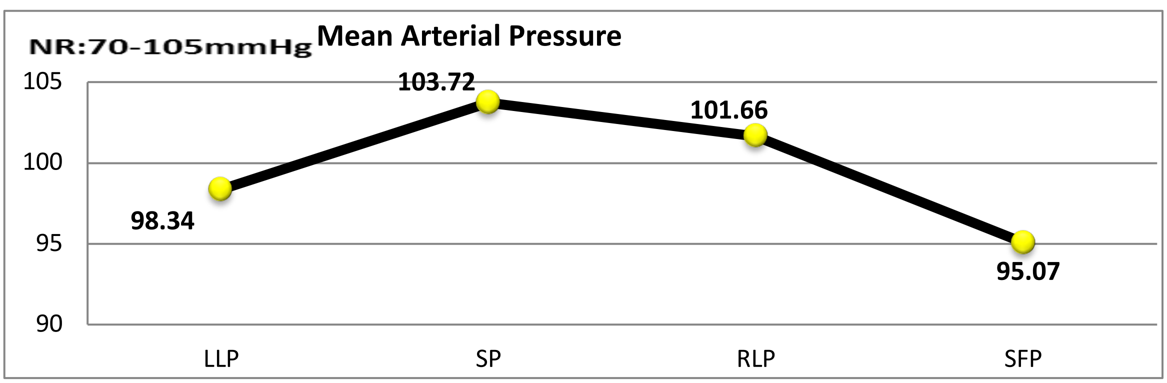


Figure (6): Comparison of mean arterial pressure (MAP) after one hour of positioning in different body positions.

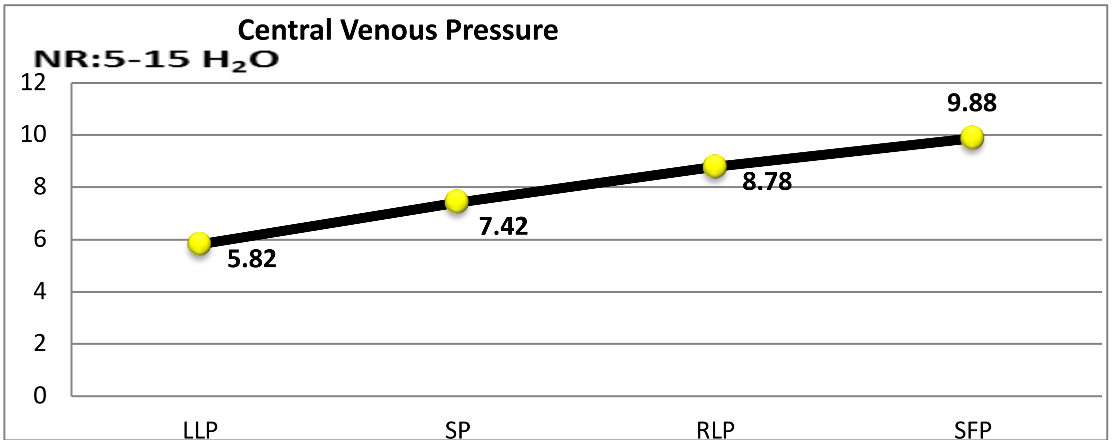
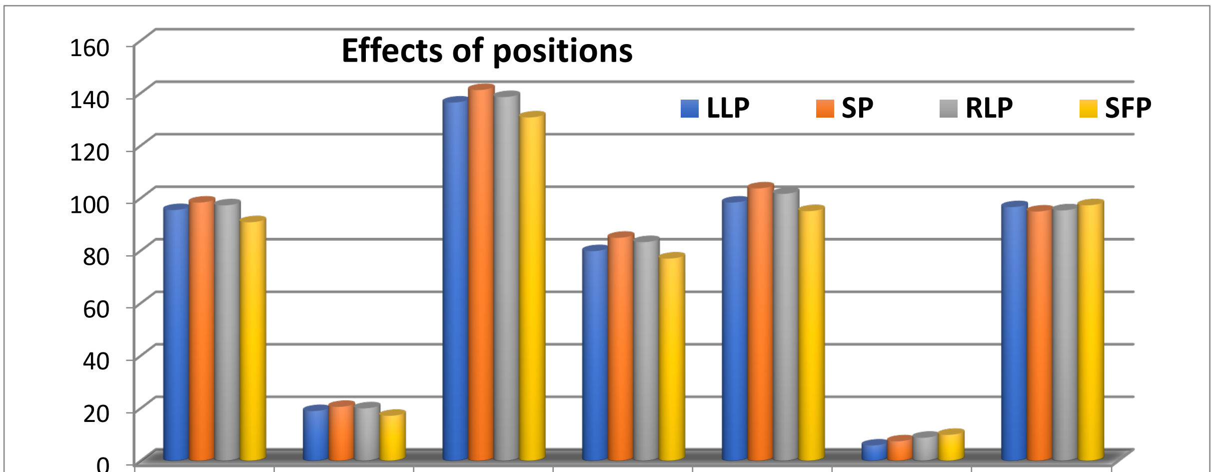


Figure (7): Comparison of central venous pressure (CVP) after one hour of positioning in different body positions.



	HR	RR	SBP	DBP	MAP	CVP	Sao2
LLP	95.49	18.94	136.42	79.85	98.34	5.82	96.6
SP	98.34	20.55	141.19	84.93	103.72	7.42	94.93
RLP	97.28	19.97	138.51	83.28	101.66	8.78	95.37
SFP	90.85	17.13	130.75	77.01	95.07	9.88	97.31

Figure (8): Comparison of different body positions with different hemodynamic parameters after one hour of positioning.

6. Discussion

Changing a patient's position to reduce pressure, increase patient comfort, and facilitate pulmonary secretions is one of the independent initiatives carried out by nurses. These initiatives contribute to protecting the patient's health and ensuring recovery. Body position and body position changes affect the optimal transport of blood and oxygen. Placing the patient in the right position at the right time improves gas exchange and contributes to recovery. Patients who are not positioned correctly face the risk of harmful or even fatal consequences due to a disruption of the ventilation/perfusion ratio and a lowered cardiac flow rate *(Ceylan et al., 2016)*. This study aimed to determine the effect of body position on oxygenation and hemodynamic status among patients with traumatic brain injury.

The current study shows that more than half of the studied sample age was ranged from 19-30 years old, with a mean age of 33.43±10.58, male subject represents the great majority. Also, near three-fourths of the study sample had secondary and university education. Additionally, more than half of the studied subjects were workers, and around one-third were employees. Besides, around three-fourths were married.

These findings may be due to the male in this age group being more likely to deal with activities that make them more susceptible to head trauma (like driving, sports, fights, or even hard work). Also, the result of the subject's occupation represents a suitable explanation. Because workers face many hard activities, this finding also may give a rationale for their normal weight (BMI), which may be due to their increased activity at this age and with their lifestyle as around two-thirds of their BMI had normal weight.

These findings are in the same line with *Okasha et al. (2012),* who studied the effect of supine and semi-fowler position on cerebral perfusion pressure among patients with acute traumatic brain injuries and found that more than half of the studied subjects their age was ranged from 25 to 30 years old.

These findings are in concordance with *Fitzharris et al. (2009),* who studied crash characteristics and patterns of injury among hospitalized motorized two-wheeled vehicle users in urban India and stated that the median age was 31 years and the great majority were males. *Styrke et al. (2007)* reviewed traumatic brain injuries in a well-defined population: Epidemiological aspects and severity and indicated that the median age of traumatic brain injury patients was 23 years.

The two-third of the studied sample's body mass index ranged between 18.5-24.9 Kg/m^2 (normal weight) with a mean of 23.48 ± 2.53. This finding is agreed with *Okasha et al. (2012),* who found that three-quarters of their studied subjects' body mass index was ranged between (20-25). In this regard, *Brown et al. (2006)* studied obesity and traumatic brain injury and found that the great majority was lean patients have a normal weight ($BMI=24\pm4$ kg/m^2).

Male worker patients represent the great majority of the studied subjects in the current study. This finding is in concordance with *Chang et al. (2015)*, who performed a systematic review of work-related traumatic brain injury epidemiology. They found that in general, male workers, those in the youngest and oldest age groups, and those working in the primary or construction industries were at elevated risk for TBI, with falls being the most common mechanism of injury, followed by motor vehicle crash (MVC) or being struck by a hard surface.

Regarding clinical variables, the current study shows that almost half of patients stayed in the intensive care unit for more than six days, with a mean length of stay of 6.85 ± 3.69. More than half of the studied subjects were mechanically ventilated. The rationale for these findings may be due to the classification of studied sample diagnosis, which needs long-term care in the intensive care unit under mechanical ventilation, which needed to prevent air from aspiration or assist oxygenation and return to the normal conscious level.

The result of the current study agrees with *Cinotti et al. (2018),* who studied management and weaning from mechanical ventilation in neurologic patients and found that in the early phase following severe brain injury (BI), mechanical ventilation (MV) is often needed to prevent the airway from aspiration, control $PaCO_2$ and PaO_2 and avoid secondary brain insults.

Additionally, more than a quarter of the studied subject was diagnosed with a skull fracture and brain contusion, followed by almost a quarter of the sample with subdural hemorrhage (SDH) and subarachnoid hemorrhage (SAH). Also, all patients received antibiotics, antiepileptic, and IV fluids with no surgical history. The current study shows that more than one-third of the sample was in a severe coma. Besides, more than one-third were in a mild coma. Regarding RASS, almost half of the sample were deeply sedated and unarousable.

The rationale for these findings may be due to the main cause of these diagnoses is road traffic accidents, cars crash, and falling from a height, which is more associated with a skull fracture, brain contusion and subdural hemorrhage (SDH), and subarachnoid hemorrhage (SAH) a result of the mechanism of injury. In this regard, *Narotam et al. (2009)* studied brain tissue oxygen monitoring in traumatic brain injury and major trauma: outcome analysis of a brain tissue oxygen-directed therapy and found that diffuse brain injury was the most common abnormality.

Besides, *Abd-El-Moaty et al. (2017)* studied the effect of semi-fowler positions on oxygenation and hemodynamic status among critically ill patients with traumatic brain injury. They found that around a quarter of the sample was diagnosed with subdural hemorrhage (SDH) and subarachnoid hemorrhage (SAH). Additionally, *Okasha et al. (2012)* studied the effect of supine and semi-fowler positions on cerebral perfusion pressure among patients with acute traumatic brain injuries. The study revealed that around a quarter of the studied sample was diagnosed with a cerebral contusion.

Although patients with brain injury (BI) are frequently hospitalized in the intensive care unit (ICU) without respiratory problems, they display longer durations of mechanical ventilation (MV) and a challenging weaning process compared to other ICU populations. Patients are undergoing BI from trauma or intracranial hemorrhage display a high prevalence of respiratory complications, longer durations of MV, and high rates of extubation failure than other ICU patients (*Asehnoune et al., 2017).*

The current study shows a statistically significant decrease in the mean scores of oxygen saturation between pre-position and post-position in the left lateral position (LLP) and supine position (SP). Also, there was a significant increase between pre-and post-position in the right lateral position (RLP). It also increased in semi fowler position (SFP), but it did not reach the significant level (SFP). Based on the comparison of oxygen saturation in different body positions, the current study reveals that, regarding the normal range, semi fowler position was the best in increasing the Oxygen saturation.

The underlying rationale for this result may be due to the role of the semi-fowler position in increasing oxygenation and decreased $PaCo_2$, which may be due to the semi-fowler position increased the tidal volume due to lowering of the diaphragm and increasing of alveolar expansion. The semi-fowler position maximizes lung volumes, flow rate, and lung capacities, increases spontaneous tidal volumes, and decreases the pressure on the diaphragm exerted by abdominal contents, and increases respiratory system compliance, so oxygenation increases.

Abd- El-Moaty et al. (2017) studied the effect of semi-fowler positions on oxygenation and hemodynamic status among critically ill patients with traumatic brain injury. They found that on 45° position, there was no statistically significant difference in oxygenation parameters (PaO_2, $PaCO_2$, SaO_2, respiratory rate RR) after 15 and 30 minutes of (45°) position.

The current study findings are similar to what was reported by *Thomas et al. (2014),* who examined the effect of seated and semi-recumbent positioning on gas exchange, respiratory mechanics, and hemodynamics of 34 ventilated intensive care patients. It revealed that putting patients in a semi-fowler position with the head of the bed elevated 45° for 30 minutes showed no statistically significant difference of respiratory rate (RR) and arterial blood gas values (PaO_2, SaO_2, $PaCO_2$).

The result of the current study was in the same line as *Martinez et al. (2015)*. They examined the influence of different degrees of the head of bed elevation on respiratory mechanics in 35 mechanically ventilated patients and found that after 5 minutes of semi-fowler position, there was an increase in oxygen saturation.

Mehta and Parmar (2017) studied the effect of positional changes on oxygenation in patients with a head injury in the intensive care unit and found that the saturation (SPO_2) values were maintained at an acceptable level in each position. It showed a minimal increase at the end of 15 min in the following sequence: supine, right-side, left side, and recline setting. However, a statistically significant improvement was noted in SPO_2 only in reclined sitting (30°-70°).

However, *Anchala (2016)* studied the effect of therapeutic positions on hemodynamic parameters among critically ill patients in the intensive care unit at Sri Ramachandra Medical Centre and found a significant increase in oxygen saturation in the semi-fowler position.

Several studies revealed an increase in SaO2 to a significant level. *Okasha et al. (2012)* studied the effects of supine and semi-fowler positions on cerebral perfusion pressure among patients with acute traumatic brain injuries. They found that after 15 minutes of semi-fowler position, there was a significant increase in SpO_2, PaO_2, SaO_2, and a significant decrease in $PaCO_2$.

The current study shows that all hemodynamic parameters show a highly statistically significant increase in the mean scores between pre-position and post-position in the left lateral position (LLP) and supine position (SP). Also, the current study reveals that all hemodynamic parameters (heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) show statistically significantly decreasing in post position in right lateral (RLP) and semi fowler position (SFP). While a significant increase in central venous pressure (CVP). The underlying rationale for this result may be that the effects of gravity on the body decrease, which made more blood flow back to the heart, and cardiac output increased in supine positions and left lateral position leads to increased blood pressure and heart rate.

In addition to increasing in (CVP) despite decreasing of other hemodynamic parameters in right lateral and semi fowler position may be due to increasing the backflow of blood from the brain towards the heart through the superior vena cava, so increase the amount of blood returning to the heart which increased volume and also affected central venous pressure.

These findings were similar to the study conducted by *Emerson and Banasik (1996),* who studied the effect of position on selected hemodynamic parameters in postoperative cardiac surgery patients (supine, 45 degrees right lateral, and 45 degrees left lateral). They stated that statistically significant differences were found in response to position in systolic and diastolic blood pressure, central venous pressure, and heart rate. Certain positions produced greater changes in selected variables, both in the total group and within specific subgroups. Also, *Anchala (2016)* studied the effect of therapeutic positions on hemodynamic parameters among critically ill patients in the intensive care unit at Sri Ramachandra Medical Centre and found a significant change in hemodynamic parameters in various therapeutic positions.

However, the findings of the current study are different from what was reported by *Mehta and Parmar (2017),* who studied the effect of positional changes on oxygenation in patients with a head injury in the intensive care unit and found that there is a decrement in pulse rate (PR), respiratory rate (RR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) occurred in all four positions at the end of 15 min. Mean pulse rate (PR) significantly decreased in each of four positions at the end of 15 min. The amount of decrement was in the following order: supine, recline sitting (30°-70°), right-side, and left-side lying.

A similar finding was revealed by *Okasha et al. (2012),* who studied the effect of supine and semi-fowler position on cerebral perfusion pressure among patients with acute traumatic brain injuries and found that pulse rate significantly increased in the supine position. *Anchala (2016)* also reported a significant difference in the mean scores of the systolic blood pressure between the study and control groups in the left lateral position. Besides, *Cicolini et al. (2011)* studied differences in blood pressure by body position (supine, fowler, and sitting) in hypertensive subjects and stated that at multivariate analysis, mean systolic blood pressure (SBP) significantly decreased if measured in fowler and sitting positions.

Additionally, *Eser et al. (2006)* showed a statistically significant increase in systolic and diastolic blood pressure in the supine position. The difference between diastolic blood pressure was not statistically significant. The research conducted by *Nakao et al.,* quoted by *Arthur et al. (2009),* stated that body position had been shown to affect the diameter, extent, and shape of the inferior vena cava, and this can indirectly affect central venous pressure.

The current study reveals that the best hemodynamic parameters and oxygen saturation compared to the normal range are in the semi-fowler position, improving the SaO_2, HR, RR, systolic, and diastolic blood pressure significantly. Semi-fowler position significantly decreases the heart rate, respiratory rate, systolic and diastolic BP, mean arterial BP. Also, it significantly increases the CVP with a non-significantly increase the oxygenation.

The underlying rationale for this result may be that cardiac output decreased as attribution to a reduction in venous return, resulting from venous pooling in the lower extremities in a semi-fowler position leading to decreased heart rate blood pressure. Furthermore, increasing central venous pressure (CVP) may be because, in a supine patient, the brain's blood flow decreased in the superior vena cava, which decreased volume and affected central venous pressure.

Abo Alizm et al. (2017) studied the effectiveness of backrest elevation on oxygenation and hemodynamic status among mechanically ventilated patients after coronary artery bypass graft surgery. They found that positioning the patients in the 45° head of bed elevation reduces the mean arterial pressure (MAP) so that the mean blood pressure value with both systolic and diastolic pressure was decreased.

Also, *Thomas and Paratz (2014)* examined the effect of the head of bed elevation on hemodynamic among mechanically ventilated patients. They found that 45-degree head of bed elevation position was associated with significant decreases in mean arterial pressure (MAP) in mechanically ventilated patients.

Besides, *Göcze et al. (2013)* studied the effect of the semi-recumbent position on the hemodynamic status in mechanically ventilated patients in a sequence of the head of bed elevation (HOBE) positions (0°, 30°, and 45°). They adopted in random order allowing 3 minutes for hemodynamic parameters to be recorded, and found that increasing the angle of HBE to 30° was associated with significant decreases in MAP.

These findings are in concordance with *Abd- El-Moaty et al. (2017)*, who studied the effect of semi-fowler positions on oxygenation and hemodynamic status among critically ill patients with traumatic brain injury found a statistically significant reduction in MAP after 30 minutes of the 30° position. In addition to a statistically significant increase in the central venous pressure (CVP) after 15 minutes of the 30° head of bed elevation (HOBE) position.

Also, the current study at the line with *Lesmana et al. (2019),* who studied the effect of changes in postural position angle degree on central venous pressure measurement and concluded that the position of the client at 0º (supine position), the CVP value tends to be lower compared to the respondents at positions of 15º, 30º, and 45º. Likewise, vice versa on the position of 45º, CVP values tend to be higher compared to 0º, 15º, and 30º positions, so the best position for performing central venous pressure is 45º positions.

However, the findings of the current study are different from what was reported by *Kim and Sohng (2016)*, who studied the effects of backrest position 30° on central venous pressure (CVP) and intracerebral pressure (ICP) in 64 patients after brain surgery and found that there was no significant change in CVP after 5 minutes of 30° position.

Also different from *Okasha et al. (2012)*, who studied the effect of supine and semi-fowler position on cerebral perfusion pressure among patients with acute traumatic brain injuries and found that after 15 minutes of semi-fowler position 30°, there was a significant increase in pulse rate, systolic blood pressure (SBP) and MAP. They also found no statistically significant difference in the diastolic blood pressure.

The findings of the current study are different from what was reported by *Agbeko (2012),* who examined the effect of the head of bed elevation on intracerebral pressure (ICP), cerebral perfusion pressure (CPP), MAP, and cerebral oxygenation in 38 brain-injured patients and found a non-significant change in MAP after 15 minutes of 30° position.

Elizabeth and Winslow (2012) stated that respiratory rate was also significantly lower in the 45 degrees position than the 90 degrees position, and mean heart rate was significantly higher in high fowler than in the flat position, which is contradicting the current study findings.

However, the findings of the current study are different from what was reported by *Meixensberger et al. (2003)*, who studied the influence of body position on tissue-PO_2, cerebral perfusion pressure intracranial pressure in patients with acute brain injury. They found that the blood pressure was unaffected by head position.

7. Conclusion

The current study concluded a statistically significant increase in the mean scores of oxygen saturation between pre-and post-position in the right lateral position (RLP) and semi-fowler position (SFP), but it did not reach the significant level with (SFP). Also, the current study reveals that all hemodynamic parameters (HR, RR, SBP, DBP, and MAP) show a statistically significant decrease in post position in right lateral (RLP) and semi-fowler position (SFP). While a significant increase in (CVP). However, it did not reach a significant level with (DBP) in the right lateral position (RLP). Finally, the current study revealed that hemodynamic parameters and oxygen saturation significantly improved regarding normal range in semi-fowler position.

8. Recommendations

Based on the findings of this research, the following recommendations suggested:

- Develop nursing practice protocol for critical care nurses to position patients at semi-fowler position (SFP) after traumatic brain injury to improve oxygenation and hemodynamic parameters.
- Backrest elevation should be decided individually for each patient according to the patient's responses, including cardiovascular and hemodynamic parameters and systemic oxygenation.
- A study can be carried out on the aspects of the performance of critical care nurses towards therapeutic positions among patients with traumatic brain injury.
- Further studies should be carried out to assess the effect of other body positions on other medical conditions.

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