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Effect of Shallow versus Deep Endotracheal Tube Suctioning on Hemodynamic Parameters in mechanically ventilated patients in Intensive Care Unit

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Abstract: *Accumulation of secretions in the endotracheal tube occurs in almost every patient in the Intensive Care Unit. Therefore, endotracheal suctioning is an essential component to maintain patent and clear airway for the intubated patient.* ***This study aimed*** *to evaluate the effect of shallow versus deep endotracheal tube suctioning on hemodynamic parameters in mechanically ventilated patients in Intensive Care Unit. This study was conducted in Anesthetic Intensive Care Unit at Tanta University Hospital. A quasi-experimental research design was utilized. A convenience sample of sixty adults, mechanically ventilated patients fulfilling the inclusive criteria and were selected and divided into two equal groups, 30 critically ill patients in each group. Deep endotracheal suction group and shallow endotracheal suction group. Two tools were used to collect the data.*

Tool I: *Mechanically ventilated patients Assessment Tool. It consisted of three parts:*

Part A: *Bio-Sociodemographic characteristics.*

Part B: *Ventilator profile Assessment Sheet.*

Part C*: Endotracheal Suctioning Assessment Sheet.*

Tool II*: Respiratory Status Assessment Tool. It consisted of two parts:*

Part A: *Chest Field Assessment sheet.*

Part B: *Hemodynamic parameters assessment sheet.*

Results*: No significant differences were observed between two studied groups in relation to $PaCo_2$, HCo_3 and PaO2, before and after suctioning. Also, the mean of RR immediately after suctioning among deep and shallow groups were 21.20± 4.745 and 17.27± 2.651 respectively. Moreover, the mean of $PaCo_2$ before suction was 45.60±4.5 among deep suction group and was 37.80±7.862 after suction with P= 0.00. Also, the mean of $PaCo_2$ was 45.63±4.737 and decreased to 38.80±7.915 among shallow suction group.*

Conclusion: *These results showed that changes of pulse, systolic and diastolic blood pressure, $PaCO_2$, PaO_2 and HCO_3 were similar in both shallow and deep endotracheal tube suctioning methods. However, significant differences were observed between deep and shallow suction groups regarding O_2 saturation and RR. Based on the results of this study,* ***it is recommended*** *that comparison of the effects of shallow and deep suctioning on the intubation time, weaning outcomes and extubation from the tube investigated in the future studies.*

Keywords: *Deep and shallow endotracheal suctioning, Mechanically Ventilated Patients, Hemodynamic Parameters and ABG.*

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I. Introduction

Maintaining patent airway and oxygenation is the primary goal of nursing intervention in intubated and ventilated patients in the Intensive Care Units (ICU). Mechanical ventilation is a lifesaving machine that widely used for critically ill patients [1, 2].

Critically ill patients undergoing mechanical ventilation often have an increase in the production of mucous and an impaired ability to clear secretions. If secretions are not cleared effectively, the patient may be at risk for infection, atelectasis and alveolar collapse [3]. Appropriate intervention for critically ill patients with endotracheal intubation have a good effect on decreasing complications such as the ventilator-associated pneumonia (VAP), length of stay and duration of mechanical ventilation[4].Endotracheal suctioning is a clinical and routine nursing procedure of airway management for critically ill patients which acts as a bronchial hygiene therapy through mechanical removal of the accumulated secretions [5, 6]. On the other hand, in some ICUs there is no evidence based materials for tracheal suctioning to guide nurses performance [7, 8, 9].

Endotracheal suctioning technique has a consequence on hemodynamic parameters of critically ill ventilated patients [10]. During this technique; contact between the tube and catheter or manual manipulation of the tube during disconnection from the ventilator connectors leads to mechanical stimulation of vagal nerve in the trachea therefore, increasing intra-thoracic pressures, cardiac output and venous return may occur [11]. Additionally, tracheal suctioning causing emotional stress, pain and fear which stimulate the sympathetic nervous system, that increases peripheral vascular resistance, potentially blood pressure, heart rate and Arterial Blood Gases (ABGs) [12].

The American Association of Respiratory Care(AARC) in **(2010**) states that successful suctioning of an intubated patient improves air exchange, breath sounds, decreases the peak inspiratory pressure (PIP), decreases airway resistance, increases dynamic compliance, increases tidal volume delivery when using pressure-limited ventilation, improves ABGs values, improves oxygen saturation (SPO_2) and removes secretions[11].

Depth of the endotracheal tube suctioning is one of the variables used reduce the side effects of suction. There are two types of endotracheal tube suctioning; shallow and deep tube suctioning. Nursing experts and patient medical condition have great role in obtaining the efficiency of each of the shallow and deep suctioning methods [13].

Deep endotracheal suctioning means insertion of the catheter until resistance or cough then withdraws it slowly 1-2 cm before the application of suction. It may be necessary to hold the suction catheter in the same place for a period of time then withdrawn slowly from the airway if a large amount of secretions are present to optimize oxygenation and ventilation [10].

On the other hand, **shallow endotracheal suctioning** means insert catheter until the point of emerging from the lumen of the tracheal tube during which stimulation of the carina should be avoided [10]. This type of endotracheal suction may be necessary for patients at low risk of adverse events such as patients' suffering from unstable cardiovascular system, acute pulmonary hemorrhage, high intracranial pressure, coagulopathy or high risk of bronchospasm and lack of cough reflex [13].

In shallow suctioning method, the catheter inserts to the tip of the endotracheal tube, and in deep suctioning method, it passes beyond the tip and enters into the trachea. In this type, after disconnecting the patient from the ventilator without applying any negative pressure, the suction catheter carried only catheter withdrawn [10, 14]. In deep suctioning method, negative pressure should not be applied until the suction catheter inserted forward until resistance met then negative pressure is applied, and the catheter pulled back one centimeter and suctioning performed, as the catheter is being withdrawn [11].

This study aimed to evaluate the effect of shallow versus deep endotracheal suctioning on hemodynamic parameters for mechanically ventilated patients in ICUs.

II. Subjects & Method

Aim of the study: To evaluate the effect of shallow versus deep endotracheal tube suctioning on hemodynamic parameters for mechanically ventilated patients in Intensive Care Unit.

Research hypotheses:

H 1: Changes in hemodynamic parameters in deep endotracheal suctioning group will be significantly higher than shallow endotracheal suctioning.

H2: The level of oxygenation change after deep endotracheal suctioning will be significantly better than shallow tracheal suctioning.

H3: Airway patency after deep endotracheal suctioning will be significantly better than shallow endotracheal suctioning.

Operational definitions:

***Deep endotracheal suctioning*:** Means insertion of catheter until resistance or cough followed by withdraws of the catheter slowly 1-2 cm. before the application of suction.

Shallow endotracheal suctioning: Means insert of catheter until the point of emerging from the lumen of the endotracheal tube during which stimulation of the carina should be avoided.

***Hemodynamic parameters**:* Numerical measurements used to evaluate whether deep or shallow tracheal suctioning induces hemodynamic changes such as heart rate, respiratory rate, systolic and diastolic blood pressure, SPO_2 and PIP and ABG.

Research design: A quasi experimental research design was utilized in the current study.

Study Setting: This study was conducted in Anesthetic Intensive Care Unit at Tanta University Hospital, which consists of 3 units 6 beds in each and a maximum 3 mechanical ventilation machines in each. It is equipped and prepared for providing care for patients with life threatening problems.

Subjects:

Sixty adult's mechanically ventilated patients fulfilling the inclusive criteria were selected based on Epi- info program and total population admitted into ICU annually and divided into two equal groups with 30 critically ill patients in each one. **Patients' inclusion criteria** include Patients of both sexes**,** receiving mechanical ventilator support during 24-48 hours and using any ventilator modes, ventilated via endotracheal tube and using open or closed suction system. All of them have endotracheal tube; Total suction time is 5-10 seconds and Suction pressure between 100-120 mmhg. **The exclusion criteria** were patients with poor hemodynamic parameters before endotracheal suctioning such as heart rate <60 beats per minute, blood pressure less than 100/60 mmHg and SPO_2<90%.

The subjects were classified into two groups as follow:

Study Group I(Deep endotracheal suctioning group): Consisted of 30critically mechanically ventilated patients who were exposed to deep endotracheal suctioning technique. The suction catheter inserted to the end of the endotracheal tube until resistance or cough was noted**.**

Study Group II (Shallow endotracheal suctioning group): Consisted of 30 critically mechanically ventilated patients who were exposed to shallow endotracheal suctioning technique. The catheter inserted until the point of emerging from the lumen of the tracheal tube.

Tools of the study: Two tools were developed by the researchers after reviewing relevant literature and used to collect the data.

Tool I: Mechanically Ventilated Patients Assessment Tool, this tool was developed by the researchers after reviewing a relevant literature. It consisted of three parts:

- **Part A: Bio-Sociodemographic characteristics:** It included data about the following items: patient's age, sex, medical diagnosis and past and present medical history.
- **Part B**: **Ventilator Profile Assessment Sheet** [15]**:** It included mechanical ventilation mode, ventilator parameters and intubation data such as reason of intubations, type and size of the endotracheal tube.
- **Part C**: **Endotracheal Suctioning Assessment Sheet** [16, 17]: This part included size of suction catheter, depth of suction catheter, frequency of suctioning, duration of total suction time and indication of suctioning.

Tool II: **Respiratory status Assessment Tool**: This tool was developed by the researchers after reviewing a relevant literature to assess respiratory status of mechanically ventilated patient. It consisted of two parts:

- **Part A: Chest field assessment** [18, 19]**:** It consisted of rhythm, pattern and depth of breathing, amount, consistency and color of secretions, chest movement and chest sound.
- **Part B: Homodynamic parameters** [5, 20]**:** This tool used to assess physiological and hemodynamic measures such as heart rate, systolic and diastolic blood pressure, oxygen saturation, respiratory rate, and SPO_2, PIP and ABGs.

Methods

Ethical Consideration: Official permission to carry out the study was obtained from the responsible authority of ICU before conducting this study through official letters from faculty of nursing explaining the purpose of the study.

Tools validity and reliability: The content validity of the developed tools was done by revision of five panels of experts in Medical **-** Surgical and Critical Care Nursing Department. All tools of the study were tested for reliability and Cronbach' alpha was used and fond to be 0.89 for tool I and 0.96 for tool II which represent highly reliable tools.

Pilot Study: Pilot study was carried out on six critically ill ventilated patients in order to test the clarity and the applicability of the different items of the developed tools. Modifications of tools were done and the six patients were excluded from the study sample. Data collection for the study was conducted in the period from November 2016 until June 2017. This study was carried out on 4 phases:

1-Assessment phase:

Assessment was done by the researchers for all mechanically ventilated patients using tool I and II for both groups who met the inclusive and exclusive criteria of this study. This phase started immediately before endotracheal suctioning to assess the base line data such as patients' ventilator profile which include mode of mechanical ventilation, initiation of mechanical ventilation and ventilator parameters. In addition, intubation data such as reason of intubations and size of the tube. Moreover, assessment of suction catheter such as type of suctioning techniques, size of suction catheter, depth of suction catheter, suction pressure, frequency of suctioning, duration of total suction time and indication of suctioning was done.

Patient assessment should be carried out before, immediately and post 15 minutes of suction such as chest field assessment which include rhythm, pattern and depth of breathing and amount, consistency and color of secretions, chest movement, and chest sound. Also, assessment of homodynamic parameters such as heart rate, respiratory rate, blood pressure, SPO_2, PIP and ABGs should be done.

2-The planning phase: This phase was formulated based on assessment phase and literature review [1, 2, 5]. Priorities and expected outcome criteria were put into consideration when planning patients care.

Expected clinical outcomes include:

- Improvement of oxygenation level
- Patients have normal vital signs
- Patients have patent airway
- Improvement of arterial blood gases

3- The implementation phase:

In this phase, all critically ill ventilated patients were hyper oxygenated with 100% oxygen for 2 minutes pre, during and post suctioning procedure [21].The diameter of the suction catheter should be limited to less than 50% of the internal diameter of the endotracheal tube which creates less negative pressure and prevents hypoxia and right upper lobe collapse or atelectasis. It also limits the risk of mucosal trauma [11, 22].

A negative pressure of 120 mmHg is recommended because high pressures may damage the mucosa and epithelial cilia of the airway [23]. Suction time should not exceed more than 10-15 seconds in order to minimize the risk of hypoxia, atelectasis and trauma [11]. Recovery period is essential when more than one catheter pass is needed and no more than three passes during any one suctioning session to maintain oxygen levels to return to baseline [14].

In study group I (Deep endotracheal suctioning group), the researcher disconnect the patient from ventilator and stop any negative pressure, the suction catheter inserted to the end of the endotracheal tube until resistance or cough was noted then it was pulled back 1-2cm and suctioning was done while removing the catheter.

In study group II (Shallow endotracheal suctioning group), critically ill patient disconnected from ventilator without negative pressure, the suction catheter was carried only to the end of the tracheal tube. After tracheal tube suctioning had finished, patient's chest was heard to ensure the airway patency and monitor the patient's oxygen saturation levels, heart rate, blood pressure, respiratory rate, ABG and PIP immediately after suctioning procedure for any decrease indicating hypoxemia.

3. The evaluation phase: All critically ill patients in both studied groups were evaluated by using tool I and II after implementation of the endotracheal tube suctioning. Hemodynamic parameters were measured before, immediately after and post 15 minutes of suctioning procedure. Comparisons were done between both groups to determine the effect of shallow versus deep endotracheal tube suctioning on hemodynamic parameters for mechanically ventilated patients.

Statistical analysis:

- The analysis was performed using statistical software SPSS version 23.
- For quantitative data, the range, mean and standard deviation were calculated.
- For qualitative data, a comparison between groups before and after intervention was done by using Chi-square test. For a comparison between two means, the independent t- test was calculated. For a comparison between more than two means, one way ANOVA test was calculated. A significance was adopted at P<0.05 for interpretation of results of tests of significance.

III. Results

Table 1: Distribution of personal characteristics of critically ill ventilated patients for both deep and shallow endotracheal suctioning groups

Personal characteristics	Studied sample (n=60)				χ^2 P
	Deep suction (n=30)		Shallow suction (n=30)		
	N	%	N	%	
Sex					
▪ Male	24	80.0	27	90.0	1.176
▪ Female	6	20.0	3	10.0	0.278
Age	Mean ±SD 41.10±10.67		Mean ±SD 44.83±8.92		t= 2.195 P=0.147
Diagnosis:					
▪ brain edema	12	40.0	13	43.3	
▪ brain trauma	6	20.0	7	23.3	0.299
▪ subdural hematoma	6	20.0	5	16.7	0.960
▪ multiple organ failure	6	20.0	5	16.7	
Mode of ventilator:					
▪ control mode	24	80.0	19	63.3	2.052
▪ SIMV	6	20.0	11	36.7	0.152

▪ CPAP	0	0.0	0	0.0	
Frequency of catheter insertion for suction:					
▪ 2 times	19	60.0	9	30.0	**6.66**
▪ 3-4 times	10	33.3	20	66.7	**0.03***
▪ > 4 times	0	0.0	1	3.3	
Size of artificial airway tube :					
▪ 6-7 mm	3	90.0	5	16.7	0.654
▪ >7	27	10.0	25	83.3	0.500
Size of suction catheter	Mean ±SD		Mean ±SD		t=0.336
	15.60±1.52		15.73±1.55		P=0.738

Significant at P< 0.005

Table (1) Shows distribution of personal characteristics of critically ill ventilated patients for both deep and shallow endotracheal suctioning groups. Regarding sex, the majority (80.0%) and (90.0%) of deep and shallow suctioning groups were male respectively. Also, the mean ages of both groups were (41.10±10.67) and (44.83±8.92) respectively. In relation to diagnosis, it was observed that more than one third (40.0%) and (43.3%) of deep and shallow suction groups diagnosed as brain edema. Regarding ventilator modes, the majority (80.0%) of deep suction group was on control mode compared to less than two third (63.3%) of shallow suction group.

Also, more than one third (36.7%) was on SIMV mode among shallow endotracheal suction group. Regarding catheter insertion per suctioning procedure, Less than two third (60.0%) of deep suction group need catheter insertion two time compared to less than one third (30.0%) of shallow suction group. On the other hand about two third (66.7) of shallow suction group need catheter insertion from3 to 4times compared to one third (33.3%) of deep suction group and P<0.05.

Moreover, the majority (90.0%) and (83.3%) of both deep and shallow suction groups had size of artificial airway tube >7 mm. respectively. In addition, the Mean ± SD of suction catheter size of both deep and shallow groups were (15.60±1.52) and (15.73±1.55) respectively.

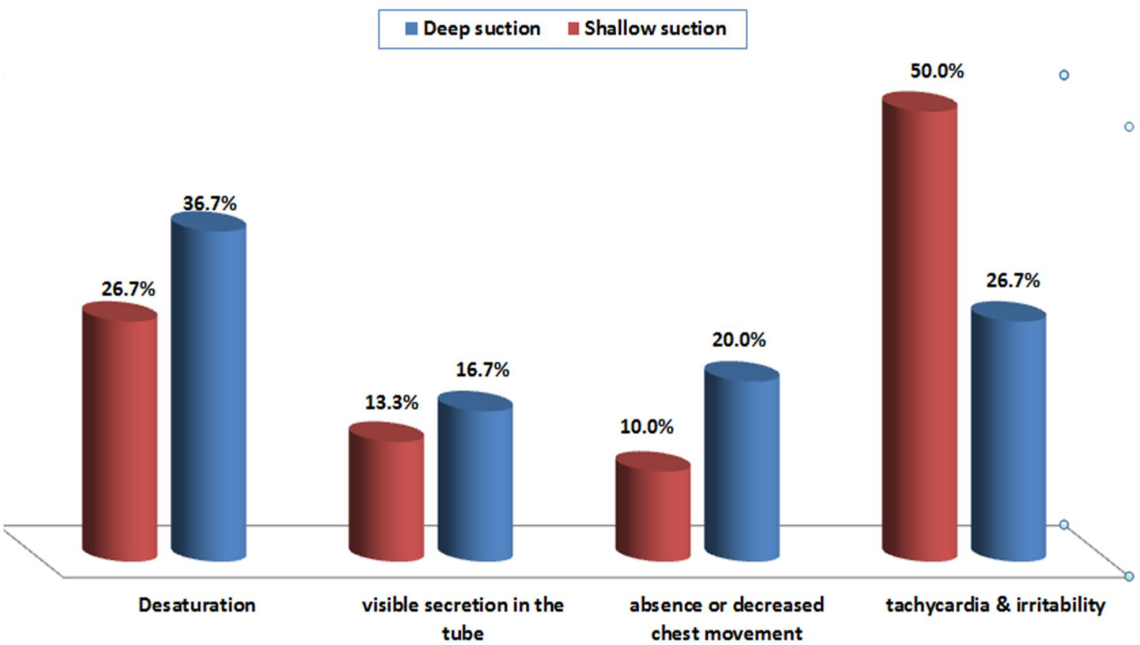

Fig (1): Distribution of studied sample according to indication of suction.

Figure (1) shows distribution of studied sample according to indication of suction. It was observed that more than one third (36.7%) of deep endotracheal suction group need suctioning due to desaturation compared to less than one third (26.7%) of shallow one. Also, one half (50.0%) of shallow suction group need suction due to tachycardia and irritability compared to less than one third (26.7%) of deep suction one. Only (10.0%) of shallow endotracheal suction group need suction due to absence or decreased chest movement.

Table 2: Distribution of both deep and shallow endotracheal suction groups according to ventilator parameters.

Ventilator parameters	Studied sample (n=60) Mean ±SD		t	P
	Deep suction	Shallow suction		
▪ Tidal volume	479.43±129.168	482.27±93.032	0.097	0.923
▪ Compliance	17.80±10.631	18.43±10.193	0.236	0.815
▪ FiO_2	67.80±27.805	66.43±26.009	0.197	0.845

Table (2) represents distribution of both deep and shallow endotracheal suction groups according to ventilator parameters. In this table, it was observed that the Mean ± SD of tidal volume among critically ill ventilated patients with deep endotracheal suction was (479.43±129.168) compared to (482.27±93.032) among patients with shallow suction. Regarding compliance, the Mean ±SD among deep endotracheal suction was (17.80±10.631) compared with (18.43±10.193) among patient with shallow endotracheal suction. Also, no significant difference was observed regarding FiO_2 among deep and shallow endotracheal suction groups

Table 3: Comparison between deep and shallowendotracheal suctioninggroups according to physiological parameters during three different times of suction.

Physiological parameters		The studied sample (n=60) Mean ± SD		t	P
		Deep suction (n= 30)	Shallow suction (n=30)		
pulse	Immediately before suction	91.73± 12.852	90.40± 10.224	3.298	0.075
	Immediately after suction	114.50± 15.296	100.23± 20.530	3.298	0.075
	Post 15 min of suction	92.66± 12.852	90.37± 10.444	2.348	0.131
	F , P	**5.187 , 0.007***	**15.188 , 0.00***		
Respiration	Immediately before suction	24.20± 3.881	22.63± 3.168	2.934	0.092
	Immediately after suction	21.20± 4.745	17.27± 2.651	**15.712**	**0.00***
	Post 15 min of suction	17.20± 4.139	18.30± 2.938	1.409	0.240
	F , P	**20.291 , 0.00***	**28.399 , 0.00***		
Systolic	Immediately before suction	103.20± 11.093	103.20± 11.056	0.00	1.00
	Immediately after suction	100.80± 7.317	101.27± 7.790	0.057	0.812
	Post 15 min of suction	102.40± 9.576	103.70± 9.370	0.282	0.597
	F , P	0.501 , 0.608	0.549 , 0.580		
diastolic	Immediately before suction	59.00± 8.937	58.00± 7.965	0.209	0.649
	Immediately after suction	53.40± 4.048	55.20± 4.334	2.764	0.102
	Post 15 min of suction	54.80± 7.117	53.87± 6.847	0.268	0.607
	F , P	**5.204, 0.007***	3.102 , 0.050		
O_2 sat	Immediately before suction	86.33±2.783	86.90±2.537	0.679	0.413
	Immediately after suction	86.73±2.716	93.37±2.220	**107.28**	**0.00***
	Post 15 min of suction	92.40±1.773	93.00±2.017	1.497	0.226
	F , P	**56.723 , 0.00***	**76.922 , 0.00***		
PIP	Immediately before suction	26.47±5.171	25.47±5.399	0.537	0.467
	Immediately after suction	25.00±4.962	21.73±6.389	**4.892**	**0.031***
	Post 15 min of suction	20.07±3.107	20.53±3.401	0.308	0.581
	F , P	**16.583 , 0.00***	**7.306 , 0.001***		

Significant at P< 0.005

Table (3) shows Comparison between deep and shallow endotracheal suctioning groups according to physiological parameters during three different times of suction. In this table, significant differences were observed among deep and shallow endotracheal suction groups in relation to pulse rate at three periods of the study with P<0.05.Also, significant difference was observed among two groups in relation to respiration immediately after suction where P < 0.05.

As well, statistical significant difference was observed among deep endotracheal suction group regarding diastolic blood pressure throughout the three period of the study with P<0.05. Regarding O_2 saturation, statistical significant difference was observed among deep and shallow endotracheal suction groups immediately after suction only with P<0.05.

Also, the mean of O_2 saturation was (86.90±2.537) and improved to (93.37±2.220) immediately after procedure among shallow endotracheal suction group with P<0.05 compared to deep endotracheal suction group where it was (86.73±2.716) before suction and (86.73±2.716) immediately after suction and become (92.40±1.773) post 15 min of suction with P<0.05.The mean of PIP was (25.00±4.962) and (21.73±6.389) among deep and shallow suction group respectively immediately after procedure, where P<0.05.

Table 4: Comparison between deep and shallow endotracheal suction groups according arterial blood gases before and after suctioning.

ABG		The studied sample (n=60) Mean ± SD		t	P
		Deep suction (n= 30)	**Shallow suction (n=30)**		
PH	**Before suction**	7.34±0.11	7.35±0.12	0.052	0.821
	After suction	7.32±0.02	7.45±0.02	**0.873**	**0.026***
F , P		0.00, 1.00	0.072, 0.79		
PaO_2	**Before suction**	96.90±10.57	96.73±2.98	1.827	0.182
	After suction	100.60±10.6	97.40±2.12	0.994	0.323
F , P		0.007, 0.93	2.61, 0.11		
$PaCO_2$	**Before suction**	45.60±4.5	45.63±4.73	0.001	0.978
	After suction	37.80±7.862	38.80±7.91	0.241	0.625
F , P		**22.16, 0.00***	**16.462, 0.00***		
HCO_3	**Before suction**	26.76±2.79	26.82±2.91	0.007	0.932
	After suction	24.84±1.91	24.94±1.94	0.043	0.837
F , P		**9.679, 0.003***	**8.646,0.00***		

*** Significant at P< 0.05**

Table (4) represents comparison between deep and shallow suction groups according arterial blood gases before and after suction. No significant difference was observed between two studied groups in relation to PH before suctioning procedure. While there was significant difference between both studied group after suctioning. With P<0.05.Regarding PaO2, the mean score was **(96.90±10.57)** before suction among deep suction group and it was **(100.60±10.6)** after suction, while it was **(96.73±2.98)** and **(97.40±2.12)** before and after suction among shallow suction group.

Moreover, the mean scores of PaCo2 were (**45.60±4.5)** and **(37.80±7.86)** before and after suction among deep suction group with P<0.05. Also, the mean scores of PaCo2 were **(45.63±4.737)** and (**38.80±7.91)** before and after the procedure respectively. In relation to HCo3, the mean score was **(26.76±2.79)** before suction and changed into **(24.84±1.91)** after suction among deep suction group with P<0.05.While it was **(26.82±2.91)** before suction and decreased to **(24.94±1.94)** after suction among shallow suction group with P<0.05.

Table 5: Distribution of both deep and shallow endotracheal suction groups according to character of secretion after suctioning procedure

Characters of secretion	Studied sample (n=60)				χ^2 P
	Deep suction group (n=30)		Shallow suction group(n=30)		
	After suction		After suction		
	N	%	N	%	
Amount of secretion					
▪ No secretion	0	0.0	0	0.0	2.857
▪ Moderate amount	18	60.0	24	80.0	0.091
▪ Large amount	12	40.0	6	20.0	
Color of secretion					
▪ clear	8	26.7	5	16.7	
▪ streaked	2	6.7	9	30.0	6.480
▪ green	8	26.7	4	13.3	0.090
▪ Milky	12	40.0	12	40.0	
Consistency Of secretion					
▪ thick/tenacious	18	60.0	20	66.7	0.287
▪ watery secretion	12	40.0	10	33.3	0.592

Table (5) shows distribution of both deep and shallow endotracheal groups of according to character of secretion after suctioning procedure. Regarding amount of secretions, It was observed that less than two third (60.0%) of studied patients in deep endotracheal suction group had moderate amount of secretion compared to the majority (80.0%) of critically ill patients with shallow endotracheal suction group after procedure. In relation to color of secretion, it was found that less than one third (26.7%) of deep endotracheal suction group had clear and green color of secretion compared to few percentage (16.7%) and (13.3%) of shallow suction group respectively. Regarding consistency of secretion, near to two third (60.0%) of deep suction and two third (66.7%) of shallow one had thick and tenacious secretion.

Table 6: Comparison between deep and shallow suction in relation to breathing assessment during three different times of suction.

Breathing assessment	The studied groups (n=60)													
	Deep suction (n=30)						χ^2 P	Shallow suction (n=30)						χ^2 P
	Before		Immediately after		After 15 min			Before		Immediately after		After 15 min		
	N	%	N	%	N	%		N	%	N	%	N	%	
Rhythm of breathing ▪ Regular ▪ Irregular	 9 21	 30.0 70.0	 18 12	 60.0 40.0	 18 12	 60.0 40.0	**7.20** **0.02***	 5 25	 16.7 83.3	 18 12	 60.0 40.0	 20 10	 66.7 33.3	**17.72** **0.00***
Deep VS shallow **Z,P**	1.491 0.222		0.00 1.00		0.287 0.592									
Pattern of breathing ▪ Normal ▪ Rapid ▪ Week	 4 21 5	 13.3 70.0 16.7	 18 12 0	 60.0 40.0 0.0	 30 0 0	 100.0 0.0 0.0	**39.94** **0.00***	 3 22 5	 10.0 73.3 16.7	 22 8 0	 73.3 26.7 0.0	 30 0 0	 100.0 0.0 0.0	**55.78** **0.00***
Deep VS shallow **Z,P**	0.166 0.920		1.20 0.273		-									
Depth of breathing ▪ Normal ▪ Deep ▪ Shallow	 0 5 25	 0.0 16.7 83.3	 12 6 12	 40.0 20.0 40.0	 30 0 0	 100.0 0.0 0.0	**63.55** **0.00***	 2 2 26	 6.7 6.7 86.7	 21 5 4	 70.0 16.7 13.3	 30 0 0	 100.0 0.0 0.0	**67.76** **0.00***
Deep VS shallow **Z,P**	3.305 0.192		**6.545** **0.038***		-									

*** Significant at P< 0.05**

Table (6) shows comparison between deep and shallow endotracheal suction in relation to breathing assessment. In this table, the majority (83.3%) of patients in shallow suction group had irregular breathing rhythm before suction and the percentage become (33.3%) after 15 min. of suction compared with most of (70%) of patients in deep suction group before suction and decreased to (40%) after 15 min of suction. In relation to pattern of breathing, it was noticed that most (70.0%) of critically ill ventilated patients in deep suction group had rapid respiration compared to (40.0%) immediately after suction. All patients in this group had normal pattern of breathing after 15 min of the procedure with P<0.05. on the other hand, most (73.3%) of patients in shallow suction group had normal pattern of breathing immediately after suction and the percentage improved to 100.0% after 15 min. of suction with P<0.05.

With regard depth of breathing, the majority (83.3%) of patients in deep suction group had shallow respiration before procedure and the percentage reached to (40.0%) immediately after suction with P<0.05. While the majority (86.7%) of patients in shallow one had shallow respiration and immediately after suction it was 70.0% with P=0.00. Also, statistical significant difference was observed between two groups immediately after suction where P<0.05.

Table 7: Comparison between both studied groups of deep and shallow endotracheal suction regarding chest sound assessment during three different times of suction.

Chest sound	Studied sample (n=60)				χ^2 P
	Deep suction Group (n =30)		Shallow suction group (n=30)		
	N	%	N	%	
Immediately before suction ▪ Normal ▪ Crackles ▪ wheezing	 0 24 6	 0.0 80.0 20.0	 0 25 5	 0.0 83.3 16.7	0.11 0.073
Immediately after suction ▪ Normal ▪ Crackles ▪ wheezing	 12 12 6	 40.0 40.0 20.0	 21 6 3	 70.0 20.0 10.0	**5.45** **0.04***
After 15 min of suction ▪ Normal ▪ Crackles ▪ wheezing	 24 0 6	 80.0 0.0 20.0	 28 0 2	 93.3 0.0 6.7	2.30 0.12

*** Significant at P< 0.05**

Table (7) Comparison between both studied groups of deep and shallow endotracheal suction regarding chest sound assessment during three different times of suction. In this table, it was observed that the majority (80.0%) and (83.3%) of patients among deep and shallow suction group respectively had crackles before suctioning with no significant differences was observed. While immediately after suction, a significant difference was observed between two studied groups regarding chest sound with $P<0.05$. However, after 15 min of suction, the majority (80.0%) and (93.3%) of patients among deep and shallow suction group respectively had normal chest sound.

IV. Discussion

Endotracheal suctioning is a powerful stimulus that can lead to intense hemodynamic and ABG changes in mechanically ventilated patients in ICU. Therefore, the aim of this study was to evaluate the effect of shallow versus deep endotracheal tube suctioning on hemodynamic parameters and ABGs in mechanically ventilated patients in ICU [(24)].

Regarding personal characteristics of critically ill ventilated patients**,** the results of present study revealed that the mean age among two studied groups were (41.10±10.675) and (44.83±8.929) respectively with no significant differences. This result was in congruent with **Shamali (2016) [(9)] and Tavangar (2016)**[(25)], they stated that the majority of studied patients were at the end of the fifth decade. Also, the current result found that the majority of patients undergoing both deep and shallow suctioning methods were male. That may be attributes that males were more affected with head injury than females. This result was consistent with **Shamali (2016) [(9)] and Tavangar (2016)** [(25)], they found that the majority of critically ill patients undergoing different methods of endotracheal tube suctioning were male.

With regards to diagnosis, the findings of the present study revealed that the most common diagnosis of both groups of deep and shallow endotracheal suctioning had brain edema. This result was consistent with **Kohan (2014)** [(26)] and **Kohan(2016)** [(27)] they reported that the most common diagnosis for mechanically ventilated patients undergoing suctioning was cerebrovascular accident. Also, **Irajpour et al. (2014)** [(13)] found that the most common diagnosis for mechanically ventilated patients undergoing deep and shallow endotracheal tube suctioning was head trauma.

In relation to mode of mechanical ventilator, the findings of present study showed that the majority of studied patients in both groups were on control mode. This may be attributed to that most of sample had brain edema and need to be on control mode on the first day of admission. This result was incongruent with **Kohan**[(26)] and **Irajpour (2014)**[(13)], they stated that the majority of studied patients had synchronized intermittent mandatory ventilation.

Concerning size of the suction catheter, the current study revealed that there was a no significant correlation in both deep and shallow endotracheal suctioning groups regarding size of catheter. This may be rationalized that the majority of patients in ICU were male and most of them used the same size of suction catheter. The result of study done by **Paymard et al., (2017)** [(28)] was contrast to the present study, they stated that there was significant difference between large and small catheters during endotracheal suction.

As well, significant correlation regarding the frequency of suctions needed to effectively clear airway between the two studied groups was observed. This finding was not in line with **Shamali et al., (2016)** [**(9)**], they stated that no significant difference in the number of suctions needed to clear airway between the two groups. On the other hand, this study was contradicted with **Abbasinia et al., (2014)**[(5)] they showed that number of suctions needed for efficient airway clearance in the shallow suctioning group was higher compared to that of the deep suctioning group.

As for indications of suctioning, the current study revealed that the most common indication of suctioning in both deep and shallow suctioning groups were desaturation, tachycardia and irritability. This may be interpreted that most of mechanically ventilated patient had disturbance in oxygen saturation on admission. This finding was inconsistent with **Brochard et al., (1991)** [(29)], they concluded that oxygen desaturation was fully prevented in more than two thirds of mechanically ventilated patients undergoing endotracheal tube suctioning.

According to physiological parameters, the current study illustrated that there was no significant increase in heart rate and slight reduction in blood pressure among patients of both groups of deep and shallow endotracheal suctioning before suction, immediately after suction and post 15 min. of suction procedure. This may be interpreted that suctioning process has an effect of on vital signs. This finding was in the same line with **Seyyed Mazhari et al (2010),**[(30)] they stated that heart rate of patients after endotracheal suctioning was significantly increased immediately after suction compared to the value immediately before procedure and returned to the normal levels after 5 min. of suctioning.

On the other hand, this study was contradicted with **Tavangar et al(2016),**[(25)] they clarified that a reduction was observed in heart rate and an increase in oxygen saturation in the three groups in after 5 and 20 minutes of suctioning compared to during and immediately after suctioning. In addition, **Van de Leur et al**

(2003), [31] clarified that shallow suctioning was significantly increased systolic blood pressure of patients, compared with routine suctioning. Additionally, **Zolfaghari et al (2008),**[32] revealed that arterial blood pressure was significantly increased in patients after 2 min of suctioning and returned to the normal levels at 5 min post suctioning.

However, a significant improvement in O_2 saturation was observed immediately after suction among patients with shallow suction method. As well, significant decreases in the mean of respiratory rate and PIP among this group immediately after suction were observed. This may be interpreting that most of physiological parameters may return to normal base line after 15 min. for both types of suctioning. This result was contradicted with **Abbasinia et al (2014),**[5] they illustrated that respiratory rate was significantly increased and SpO2 was significantly decreased after each suctioning in the both groups. However, these changes were not significant between the two groups.

In relation to arterial blood gases, the current study revealed that there was statistical improvement in PH among patients of shallow endotracheal suctioning after suctioning. While, there was an improvement in the mean of PaO2 among deep suction group after the procedure. These results also revealed that no significant changes were observed among two groups regarding $PaCO_2$.This may be rationalized that the both deep and shallow endotracheal suction has similar effect on ABG parameters after suctioning process. This study was in the agreement with **Kohan et al (2014),** [26] they showed that there were statistically significant differences in PaO2 and $PaCO_2$ at different measuring points. As for respiratory assessment, the findings of the present study showed that more than one third of patients in deep suction group had large amount of secretion. It may be due to the majority of mechanically ventilated patients in both of groups were unconscious and unable to cough to assist in the removal of airway secretions. This finding was in the same line with **Ntoumenopoulos et al(2017)**[33], they showed that one-third of intubated and ventilated patients received additional secretion clearance techniques. Mucus plugging events were infrequent and need for additional secretion clearance approaches.

V. Conclusion

The results of this study showed that changes of pulse and Systolic, diastolic, $PaCO_2$, PaO_2 and HCO_3 were similar in both shallow and deep endotracheal tube suctioning methods. However, a significant difference was observed between deep and shallow suction groups regarding $SPO_2$and PH. Therefore, it seems that shallow endotracheal tube suctioning method can be used to clean the airway with lesser manipulation of the trachea.

VI. Recommendation

According to the results of this study, it is recommended that in-services training program for nurses about deep and shallow endotracheal suction for updating their knowledge and performances In ICU.

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