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Comparing Between the Effectiveness of Twill and Adhesive Tape Techniques in Securing the Endotracheal Tube and Maintaining the Integrity of Oral Mucous Membrane among Critically Ill Patients

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1.ABSTRACT

Background: Tracheal intubation is one of the most common emergency procedures performed for patients in intensive care units. Many life-threatening complications result from improper nursing management regarding endotracheal tube fixation. Various techniques have been utilized by critical care nurses to ensure endotracheal stabilization in order to maintain a patent airway and prevent or minimize complications. The optimal stabilization method should not only be secured but also requires other considerations as ease of use, few complications, and time effectiveness with patient comfort. Thus, this study **aimed** to compare the effectiveness of Twill and adhesive tape techniques in securing the endotracheal tube and maintaining the integrity of the oral mucous membrane among critically ill patients. **Method:** A quasi-experimental research design was utilized to conduct this study among 74 orally intubated patients in three surgical intensive care units affiliated with Mansoura Emergency Hospital in Egypt. Two tools were used to collect data for this study; endotracheal tube placement assessment sheet and oral assessment guide scale. **Result**s: There were highly statistically significant differences between the two groups regarding the ETT slippage at 30, 60, and 120 minutes ***(P* =0.011 <0.001& < 0.001).** Moreover, 5.4% of the participants in the Twill group had severe oral mucositis compared with 27% of the participants in the adhesive tape group with statistically significant differences between the two groups (***P* < 0.001). Conclusion:** The Twill technique is more effective than the adhesive tape technique for securing the ETT and maintaining the integrity of the oral mucous membrane among critically ill patients. Therefore, the Twill technique is recommended to be used in intensive care units to ensure effective management during ETT routine care and avoid the occurrence of slippage.

Keywords: Endotracheal tube, Twill technique, Adhesive tape technique, Critically ill patients

2.Introduction:

Endotracheal intubation is a life-saving procedure that maintains oxygen supply and airway patency and plays an important role in the rescue of critically ill patients (Beloncle, Lorente, Esteban, & Brochard, 2014). One of the most serious and common complications after the endotracheal tube (ETT) insertion is unplanned extubation with a wide range prevalence in various reports from 1.6% to 22% (da Silva & Fonseca, 2012). In Egypt, a recent study carried out in Respiratory ICU, Zagazig University to examine "the incidence, risk factors, and consequences of unplanned extubation" revealed that 11.02% of the studied patients experienced unplanned extubation (Abbas & Lutfy, 2019). Additionally, unplanned extubation had a prolonged length of stay (13.28 ±3.92 days), a higher reintubation rate (44.5%), and a higher mortality rate (29.6%).

Partial unplanned extubation is known as slippage of the ETT. It occurs when the ETT dislodged more than 2 cm^2 but its tip is still within the vocal cords (Seyedhosseini, Ahmadi, Nejati, Ardalan, Ghafari, & Vahidi, 2017). Securement of the ETT is the last step of tracheal intubation and it is the responsibility of nursing and respiratory care professionals (Lucchini et al., 2018). Maintenance of the ETT fixation prevents its slippage and unplanned extubation, maintains alignment of the ETT within the trachea, and preserves the skin integrity of the face and neck with adequate levels of venous return (Mohammed & Hassan, 2015). The ineffective ETT fixation can induce tube slippage (Lakhani, Flanders, & Gorniak, 2020), increase external jugular venous pressure, facial skin, and mucosal breakdown (Alberto et al., 2018; Reaper, Gupta, & Tiruvoipati, 2017), and finally increase the risk of re-intubation (Alberto et al., 2018). According to Epstein, Strashewsky, Furer, Tsur, Chen, and Lehavi. (2020), re-intubation is associated with many adverse sequelae such as hypoxia, ventilator-associated pneumonia (VAP), intraventricular hemorrhage, and cardiopulmonary arrest.

A myriad of methods was established for ETT securement. It varies from tape straps (adhesive, cotton, or Twill) to mechanical devices

with constructed mechanisms of securing such as commercial tube holders (Hampson et al., 2018). By preserving an intact airway and lowering the danger of ETT slippage, these techniques and strategies attempt to keep the artificial airway secure while assuring patient safety (Danielis, Chiaruttini, & Palese, 2018). The selection of an optimal ETT securing device continues to be problematic because of the dual need for stability of the ETT and prevention of trauma to the skin and mucosa (Kim & Lee, 2019). ETT securing technique should provide optimum stability against the unintended movement, and resistance to oral secretions without becoming loose and prevent the ETT slippage. It should also be simple to use and applied with a minimal time commitment (Mussa et al., 2018).

Hence, the unresolvable conflicts of opinion about the optimum technique of the ETT securement lead to an increase in the number of accidental extubations in the ICU, as well as variability in practice (Wagner et al., 2018). ETT tube fixation technique may be ideal if it causes less than 1 cm of proximal tube displacement and less oral mucosa breakdown. The method should also ensure maximum patient comfort and oral hygiene (Seyedhosseini et al., 2017). There has been no comparison or evaluation of these strategies to determine which is the best method for securing the ETT. Furthermore, excessive pressure from ETT securing on the surrounding tissue can harm the skin and mucosa. This is due to pressure points caused by the securing procedure, which reduces the local perfusion of the tissue. Moreover, securing procedures can be a painful process that affects patient comfort.

Accidental extubation is becoming more common in Egyptian ICUs, and there is a lot of variation in practice due to unresolvable conflicts of opinion about the optimum method for securing the ETT. This inspired us to investigate this area

Aim of the study

This study aimed to compare the effectiveness of Twill and adhesive tape techniques in securing the ETT and maintaining the integrity of the oral mucous membrane among critically ill patients.

Research hypothesis

The current study hypothesized that the Twill technique would be more effective in securing and preventing ETT slippage, and maintaining healthy oral mucosa than the adhesive tape technique.

3.Method

3.1.Design

A quasi-experimental research design was utilized in this study. This design is used to estimate the effect of an intervention on some outcomes without randomization (LoBiondo-Wood & Haber, 2017). It offers important opportunities to improve evidence on cause-effect relationships and it is more frequently used in nursing science for being more suitable for real-world natural settings than true experimental research designs (Steiner, Kim, Hall, & Su, 2017).

3.2.Setting

This study was conducted in three surgical Intensive Care Units (ICUs) affiliated with Mansoura Emergency Hospital. Each unit has 10 beds and provides care to patients who have surgical, medical, or neurological problems, and those with multiple trauma injuries. These units are well equipped with advanced technology such as cardiac monitors, mechanical ventilators, oxygen supplementation units, suction machines, manual defibrillator machines, crash carts, and manpower required for patients' care. According to the hospital's records, these units receive about 650 patients annually from Mansoura city and neighborhood. The nurse-patient ratio in these units is nearly 1:2.

3.3.Participants

A convenience sample of 74 adult critically ill patients of both genders who were newly admitted to the above-mentioned settings during the study period were enrolled in the current study according to the following inclusion criteria:

- Adult patients ≥ 18 years old.
- Orally intubated mechanically ventilated patients for at least 48 hours.

Exclusion criteria

If the patients had any of the following criteria, they were excluded from the study:

- Tracheostomy or nasotracheal intubation.
- Breakdown of the oral mucosa or facial skin
- Oral infection.
- A previous neck injury, projecting upper teeth, or the absence of teeth.

Patients were randomly divided into two equal groups; the Twill and the adhesive tape

technique groups (37 patients in each group). The Twill technique group involved patients who received a cotton tape that took shape T for the securement of the ETT. The adhesive tape group involved patients who received blaster tape for the securement of the ETT (the routine care of the unit).

3.4.Sample size calculation

The sample size was calculated through ClinCalc.com using sample size calculator software (https://clincalc.com/stats/samplesize.aspx), at 1% ∞ error (99.0% significance) and 10.0% β error (90.0% power of the study). This calculation assumed that the percentage of the healthy oral mucosa after 24 hours of the ETT fixation was 80% in the Twill technique group and 37% in the adhesive tape technique group (Mohammed & Hassan, 2015).

3.5.Data Collection Tools

Two tools were used for data collection:

Tool I: Endotracheal Tube Placement Assessment Sheet

This tool involved two parts as follows:

Part I: Patients' Socio-Demographic Characteristics and Health Profile

This part was developed by the primary investigator (PI). It was used to collect data about patients' socio-demographic characteristics including patient's age, gender, marital status, and level of education. It also covered patients' health profile including the date of admission, health history, medical diagnosis, and days on MV.

Part II: Endotracheal Tube Slippage Scale

This part was adopted from Santhosh, Torgal, Pai, Roopa, and Rao (2013). The following scale was utilized to determine the ETT slippage degree measured in cm^2 from the point of ETT fixation at the central incisor teeth of the participants. It was classified into four categories according to the changes of the ETT movement:

- **No slippage** < 0.5 cm^2= no risk for accidental extubation
- **Mild slippage** 0.5 ≤ 1 cm^2= mild risk for accidental extubation
- **Moderate slippage** 1 ≤ 2 cm^2= moderate risks for accidental extubation
- **Severe slippage** 2 ≤ 5 cm^2= high risks for accidental extubation

According to Santhosh et al. (2013), the content validity of the ETT slippage scale for mechanically ventilated patients was found to be high (Interclass Correlation Coefficient (ICC=0.95) with high reliability (ICC = 0.94).

Tool II: Oral Assessment Guide (OAG) Scale

This tool was adopted from Aoki et al. (2018). It was used to assess the effect of the ETT securement technique on oral mucosa integrity. The scale was classified into three scores according to oral mucosa integrity:

- **Score 1** for normal findings (pink and moist) = healthy oral mucosa.
- **Score 2** for moderate abnormality without compromise of either mucosal integrity or loss of function (dry, reddened, or cracked) = moderate oral mucositis.
- **Score 3** for severe abnormality with a compromise of either mucosal integrity or loss of function (ulcerated or bleeding) = severe oral mucositis.

3.6.The validity of the Tools

According to Aoki et al. (2019), the content validity of the OAG scale was found to be high (ICC=0.96.73) with high reliability (ICC = 0.95.32).

3.7.Pilot study

A pilot study was carried out on 10% of the total sample (8 patients) before starting the data collection to ensure the feasibility, objectivity, applicability, clarity, and adequacy of the study tools. Participants in the pilot study were excluded from the main study sample. Moreover, the pilot study estimated the required time for completing the datasheet.

3.8.Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Nursing – Mansoura University. After that, official approval was obtained from the hospital's administrative authority after providing details about the nature of the study. The ICUs staff was informed about the study before initiating the data collection process. Written informed consent was obtained from the participant's next of kin after informing them about the study's aim, procedure, benefits, and risks. Patients' relatives were assured that participation in the study was voluntary and refusing to allow their patients to take part in this study would not affect the care or treatment they receive in the ICU. They were also assured that the patient's personal data would be kept confidential

and that they had the right to withdraw the patient from the study at any time without responsibility.

3.9.Data Collection / Procedure

Data were collected by the PI between April and September 2020. Patients' next of kin were interviewed on the first day of the patient's admission during the official ICU visit hours and were informed about the nature of the study. Once the next of kin agreed to allow the patient to participate in the study, the data collection process was commenced. The study procedure was carried out through three phases: preparation, implementation, and evaluation.

Preparation Phase

- During this phase, an initial assessment was done by the PI for all orally intubated mechanically ventilated patients to confirm that they met the inclusion criteria and were free from the exclusion criteria.
- A flashlight and tongue depressor were used during the patient's assessment for more visualization of the oral cavity.
- All equipment needed for the procedure was prepared by the PI such as cotton tape, C-shaped foam, adhesive tape, a suction machine with its connecting tube and sterile catheter, manual resuscitation bag, sterile gloves, disposable gloves, a ruler, and oral jell.
- Demographic and health-relevant data of the participant patients were obtained from their records using part I of tool I.

Implementation phase

Based on the work completed in phase one, the PI performed the procedure after reviewing evidence-based practice related to the ETT fixation techniques (Suttapanit et al., 2020; Landsperger, Byram, Lloyd, & Rice, 2019; Hampson et al., 2018; Smith & Pierantonio, 2016; Mohammed & Hassan, 2015).

For the Twill technique group

- The old adhesive tape was removed by the PI from around the patient's ETT with an assistant from the critical care nurse who fixed the ETT in its place. Then the PI cleaned the patient's mouth using a cotton sponge soaked in water.
- The C-sponge (a foam item in the shape of a C that fits over the patient's mouth and lips) was placed to relieve the pressure of the Twill tape.
- The ETT was wrapped in a T shape using 12 mm cotton tape folded in half.
- The ends of the Twill tape were brought through this loop and then tightened by pulling the ends.
- One end of the Twill tape was wrapped around the patient's head above one ear, and the other end was wrapped around the patient's head above the other ear. The patient's cheeks were then knotted with the two ends.
- The ETT was secured by the two ties with the second piece of T shape tape by repeating the previous step.
- Finally, skin preparations with a small amount of oral jell (Miconaz) were applied to all surfaces of the oral mucous membrane contact to Twill technique as routine care in the ICU, and the C-sponge was changed after each oral hygiene appointment.

For adhesive tape technique group

- The old tape was removed by the PI from around the patient's ETT with an assistant from the critical care nurse who fixed the ETT in its place. Then the PI cleaned the patient's mouth using a cotton sponge soaked in water.
- The PI cut two strips of one adhesive tape, one measuring 90 m^2 and the other measuring 30 m^2.
- The shorter strip was centered on the top of the longer strip and the sides were stacked together to prevent hair at the nape of the neck from sticking to the tape.
- The sticky ends were folded over and clipped approximately 1 cm^2.
- A tongue depressor was placed on the distal ends of the adhesive tape and folded over it.
- After drying and forming a firm grip, skin preparations with a small amount of oral jell (Miconaz) were applied to all surfaces of the oral mucous membrane contact to adhesive tape as routine care in the ICU.
- Finally, the ETT tube was wrapped with adhesive tape and stuck to the maxilla above the top lip and down the lower lip area.

For both groups

- The patient's skin was cleaned and shaved by the PI when necessary.
- Oral hygiene was performed by the PI every 12 hours, and oral moistening was done every 2 hours based on the policy of ICUs.
- Each ETT fixation technique was renewed after 24 hours for each patient to avoid persistent pressure in a single point **(Santhosh et al., 2013).**

Evaluation phase

- The four categories of the ETT slippage scale were used to measure the ETT degree of slippage in both studied groups. A ruler scale in cm2 was used to perform the measurement. The movement of the ETT from the fixation point at incisor teeth was recorded at 15, 30, 60, and 120 minutes post the fixation of the ETT in both securement techniques.
- The three scores of the oral mucosa assessment guide were evaluated in both studied groups at 2, 6, 12, and 24 hours post the fixation of each technique to assess oral mucosa integrity.
- The percentage of participants in each fixation technique who obtained severe slippage degree of the ETT from the fixation point was recorded.
- Severe oral mucositis was evaluated to ensure the most effective technique for fixation of the ETT.

3.10.Data Analysis

Data were coded, tabulated, and analyzed by using the Statistical Package for Social Sciences (SPSS) version 24.0. Descriptive statistics were used to analyze the sample with a 95% confidence interval. Continuous variables were presented as means ± standard deviations (SD). Categorical variables were reported as numbers and proportions. Continuous data were checked for normality and equality of distribution before any analysis being performed. The independent t-test was used for continuous normally distributed variables. The Chi-square test was used for comparing categorical variables. The statistical significance level *P* value was set at < 0.05.

4.Results

Table 1 illustrates the socio-demographic characteristics of the two study groups. It showed that the mean age of the participants in the Twill technique group was 47.70 ± 16.90 compared with 53.51 ± 16.31 for the adhesive tape technique group. Concerning gender, it was noted that most of the participants in both groups were males. It represents 67.6% of the Twill group compared with 59.5% of the adhesive tape group.

Regarding the education level, more than one-third of the participants in the Twill group and adhesive tape group achieved preparatory school level (42.3% & 40.5%, respectively). Additionally, 64.9% of the participants in the Twill technique group were married compared with 70.3% in the adhesive tape technique group. As regards occupation, it was found that 59.5% of the Twill technique group were not working compared with 75.7% of the tape group. The differences between the two groups regarding the socio-demographic characteristics were not statistically significant.

Table 2 shows the health profile data of the two groups. The results illustrated that the vast majority of the participants in the two studied groups had neurological disorders (94.6% & 97.3% respectively), and 35.1% of them had 4 days length of stay on the mechanical ventilation (MV). Asking about the history of health problems, it was found that nearly two-thirds of the participants in the Twill group and adhesive tape group had a history of endocrine diseases (64% & 65.4% respectively). Additionally, 84.6% of the participants in the group of the adhesive tape had a history of cardiovascular diseases. The differences between the two groups regarding health profile data were not statistically significant.

Table 3 compares the ETT slippage scale between the studied groups. It was observed that none of the participants in the two groups had *ETT slippage at 15 minutes*. However, *at 30 minutes*, all the participants in the Twill group had no ETT slippage compared with 81.1% of the adhesive tape group. It was also noticed that the vast majority (97.3%) of the participants in the Twill group had no *ETT slippage at 60 minutes* compared with 40.5% of the participants in the adhesive tape group.

Concerning the occurrence of *ETT slippage at 120 minutes*, only 16.2% of the Twill group had mild ETT slippage compared with 51.4% of the participants in the adhesive tape group. Moreover, 2.7% of the Twill group had moderate slippage compared with 32.4% of the adhesive tape group. Finally, there were highly statistically significant differences between the two groups regarding the ETT slippage at 30, 60, and 120 minutes **($P = 0.011$, < 0.001 & < 0.001** respectively**).**

Table 4 compares the OAG scale between the studied groups. No statistically significant

differences were noted between the Twill group and the adhesive tape group regarding the assessment of oral health status at 2 and 6 hours. Concerning the assessment of oral health at 12 hours, it was observed that 91.9% of the Twill group had healthy oral mucosa compared with 62.2% of the adhesive tap group. Additionally, 8.1% of the Twill group had moderate oral mucositis compared with 37.8% of the adhesive tape group with statistically significant differences between the two groups (***P* < 0.002**).

As regards the oral health assessment at 24 hours, it was noted that 70.3% of the participants in the Twill group had healthy oral mucosa compared with 16.2% of the adhesive tape group. However, 24.3% of the participants in the Twill group had moderate oral mucositis compared with 56.8% of the participants in the adhesive tape group. Furthermore, only 5.4% of the Twill group had severe oral mucositis compared with 27% of the adhesive tape group with statistically significant differences between the two groups (***P* < 0.001**).

Table 1 ***Socio-Demographic Characteristics of the Studied Groups***

Variables	Twill group		Adhesive tape group		Significant test	
	N (37)	%	N (37)	%	χ^2	P value
Age						
• 18-30	9	24.3	4	10.8	5.380	0.140
• 31-40	3	8.1	6	16.3		
• 41-50	7	18.9	3	8.1		
• >50	**18**	**48.8**	**24**	**64.9**		
$\bar{X}$± SD	47.70 ± 16.90		53.51 ± 16.31			
Gender						
• Male	**25**	**67.6**	**22**	**59.5**	**0.525,**	**0.469**
• Female	12	32. 4	15	40.5		
Current marital status						
• Single	7	18.9	6	16.2	1.024	0.827
• Married	**24**	**64.9**	**26**	**70.3**		
• Widow	4	10.8	2	5. 4		
• Divorced	2	5. 4	3	8.1		
Education						
• Illiterate	10	27	**15**	**40.5**	**6.602**	**0.160**
• Preparatory	16	**42.3**	15	40.5		
• Secondary	8	21.6	6	16.2		
• University	3	8.1	1	2.7		
Occupation						
• Employed	15	40.5	9	24.3	2.220	0.136
• Unemployed	22	**59.5**	28	**75.7**		

Data are expressed as numbers (N) and frequency (%), $\bar{X}$: mean, SD: standard deviation

Table 2 ***Health Profile Data of the Studied Groups***

Variables	Twill group		Adhesive tape group		Significant test	
	N (37)	%	N (37)	%	χ^2	P value
Medical Diagnosis						
• Neurological disorders	35	**94.6**	36	**97.3**	**3.014**	**0.487**
• Respiratory disorders	2	5. 4	0	0.0		
• GIT disorders	0	0.0	1	2.7		
Days on mechanical ventilation						
• 2 days	1	2.7	2	5.4	1.110	0.893
• 3 days	3	8.1	5	13.5		
• 4 days	13	**35.1**	13	**35.1**		
• 5 days	10	27.0	8	21.6		
• ≤6 days	10	27.0	9	24.3		
History of health problems						
• Yes	25	**67.6**	26	**70.3**	**0.053**	**0.802**
• No	12	32.4	11	29.7		
Type of the problem						
• Neurological	4	16.0	2	7.7	2.650	0.674
• Respiratory	4	16.0	2	7.7		
• Cardiovascular	15	60.0	22	**84.6**		
• GIT	1	4.0	1	3.8		
• Renal	4	16.0	6	23.1		
• Endocrine	16	**64.0**	17	65.4		
• Cancer	1	4.0	0	0.0		

Data are expressed as numbers (N) and frequency (%), GIT: gastrointestinal

Table 3 ***Comparing the ETT Slippage Scale Between the Studied Groups***

Variables	Twill group		Adhesive tape group		Significance test	
	N (37)	%	N (37)	%	χ^2	value
ETT Slippage at 15 min						
• None (<0.5 cm^2)	37	100.0	37	100.0		
• Mild (0.5 ≤ 1 cm^2)	0	0.0	0	0.0		
• Moderate (1≤ 2 cm^2)	0	0.0	0	0.0		
• Severe (2 ≤5 cm^2)	0	0.0	0	0.0	---------	-------
ETT Slippage at 30 min						
• None (<0.5 cm^2)	37	100.0	30	81.1		
• Mild (0.5 ≤ 1 cm^2)	0	0.0	7	18.9		
• Moderate (1≤ 2 cm^2)	0	0.0	0	0.0		0.011*
• Severe (2 ≤5 cm^2)	0	0.0	0	0.0		
ETT Slippage at 60 min						
• None (<0.5 cm^2)	36	97.3	15	40.5		
• Mild (0.5 ≤ 1 cm^2)	1	2.7	16	43.2		
• Moderate (1≤ 2 cm^2)	0	0.0	6	16.2	27.882	<0.001*
• Severe (2 ≤5 cm^2)	0	0.0	0	0.0		
ETT Slippage at 120 min						
• None (<0.5 cm^2)	30	81.1	4	10.8		
• Mild (0.5 ≤ 1 cm^2)	6	16.2	19	51.4		
• Moderate (1≤ 2 cm^2)	1	2.7	12	32.4	37.950	<0.001*
• Severe (2 ≤5 cm^2)	0	0.0	2	5.4		

Data are expressed as number (N) and frequency (%), (*) statistically significant at $p \leq 0.05$, χ^2: Pearson Chi-squareETT: endotracheal tube min: minutes

Table 4 ***Comparing the OAG Scale Between the Studied Groups***

OAG Scale Scores	Twill group		Adhesive tape group		Significance test	
	N (37)	%	N (37)	%	χ^2	P value
At 2 hrs						
• Healthy oral mucosa(OAG =1)	37	100.0	37	100.0	---------	---------
• Moderate oral mucositis(OAG =2)	0	0.0	0	0.0		
• Severe oral mucositis(OAG =3)	0	0.0	0	0.0		
At 6 hrs						
• Healthy oral mucosa(OAG =1)	37	100.0	36	97.3	---------	1.00
• Moderate oral mucositis(OAG =2)	0	0.0	1	2.7		
• Severe oral mucositis(OAG =3)	0	0.0	0	0.0		
At 12 hrs						
• Healthy oral mucosa(OAG =1)	34	91.9	23	62.2	9.240	<0.002*
• Moderate oral mucositis(OAG =2)	3	8.1	14	37.8		
• Severe oral mucositis(OAG =3)	0	0.0	0	0.0		
At 24 hrs						
• Healthy oral mucosa(OAG =1)	26	70.3	6	16.2	22.633	<0.001*
• Moderate oral mucositis(OAG =2)	9	24.3	21	56.8		
• Severe oral mucositis(OAG =3)	2	5.4	10	27.0		

Data are expressed as number (N) and frequency (%), (*) statistically significant at $p \leq 0.05$,
χ^2: Pearson Chi-square OAG: oral assessment guide h: hours

5.Discussion

The current study involved a sample of 74 participant patients. They were randomly assigned into two groups: the Twill group and the adhesive tap group. As a baseline for comparison, no significant differences were noted between the two groups regarding the socio-demographic characteristics. The similarity of the two studied groups was required to avoid any negative confusing regarding the effect of these characteristics on the outcome of the study. Additionally, it was important to ensure that the two groups were comparable and that randomization was successful (Mohmmed & Hassan, 2015). These findings are supported by other similar studies (Landsperger, 2019; Lee et al., 2015). Regarding the participants' age and gender, the findings of the current study showed that the elderly males were predominant in the two studied groups. This could be because the incidence of respiratory diseases and neurological disorders are increased with advanced age in males than females that make them require ICU admission for intubation and MV. These results are in harmony with other research findings (Seyedhosseini et al., 2017).

Concerning marital status, nearly two-thirds of the Twill group and more than two-thirds of the adhesive tape group were married. This is expected considering the participants' age and gender as well as the nature of our society's culture. This finding is in agreement with the findings of the study conducted by Keawnantawat, Thanasilp, and Preechawong (2018) which reported that around half of the study population were married.

Regarding the level of education, the findings of the current study showed that nearly half of the participants in the two groups achieved the preparatory school level. This could be because all participants were from villages near Mansoura city. This is contradicted with Elsaed, Mohamed, and Ebrahim (2020) who reported that nearly two-thirds of the participants in their study pass a university level of education because more than half of them lived in urban areas.

As regards the occupation, this study revealed that more than half of the participants in the Twill group were not working compared with about three-quarters of the adhesive tape technique group. This could be because most of the participants were elderly people and they retired according to the Egyptian government's laws. On

the contrary, Abozeid, Elshamy, Salama, and Emadeldin (2019) reported that most of the study subjects were working. This contradiction may be attributed to the young age of the majority of their study sample (mean age 43.25 ± 12.34) and their educational level.

Regarding the medical diagnosis, the current study found that the vast majority of the participants in the two studied groups had neurological disorders. This is not a surprising finding as most of the participants had a hemorrhagic stroke during the data collection period. Additionally, the study setting provides care for neurological and surgical disorders. Globally, neurological disorders are the leading cause of disability, and it is believed that hundreds of millions of people around the world suffer from such disorders. Additionally, 10% of all emergency room visits are for some types of neurological complications (World Health Organization [WHO], 2016).

The current study also illustrated that nearly two-thirds of the participants in the two groups had a past medical history of endocrine diseases (diabetes). However, most of the participants in the adhesive tap group had a history of cardiovascular disease. According to the Centers for Disease and Control (CDC) annual diabetes statistics report, more than 34 million Americans have diabetes, accounting for approximately 11% of the population (CDC, 2020). Furthermore, it is estimated that 1.13 billion individuals globally suffer from hypertension, with the majority of them living in low and middle-income nations (WHO, 2019). Additionally, in Eygpt, about 80% of the patients admitted to ICUs had a past medical history of cardiovascular diseases (CVDs), diabetes, and chronic respiratory diseases **(**Hussein, Mahmoud, Awad, & Mahmoud, 2020).

Regarding patients' days on MV, the findings of the current study showed that more than one-third of patients in both studied groups had four days of the length of stay on MV. These findings could be due to the medical diagnosis of the participants, as the vast majority in the two studied groups had neurological disorders especially hemorrhagic stroke, and most of them had a bad prognosis and low Glasgow coma scale. Similarly, Chao et al. (2017) reported that the length of ICU stay for patients with neurological disorders was less than the patients with respiratory failure.

Concerning the study findings of the ETT slippage scale between the two studied groups at 15, 30, 60, and 120 minutes, it was noted that there was no significant slippage between the two groups at 15 minutes. It may be because 15 minutes after ETT fixation is a short time to cause slippage of the ETT related to the invasive procedures. This is harmonious with a study conducted by Seyedhosseini et al. (2017) which demonstrated a comparison between two ETT securing techniques; the Twill versus adhesive tape and reported that the slippage did not occur over a short period from starting the fixation time.

However, at 30 minutes, the findings illustrated a statistically significant difference between the two groups. The participants in the Twill group had no slippage compared to mild slippage in the adhesive tape group. This could be attributed to the fact that two-thirds of the study sample were males and had chin hair that made the adhesive tape lose easily than the participants in the Twill group. This finding is in agreement with the study conducted by Buckley, Brown, Shin, Rogers, and Hoftman (2016) that compares the effect of ETT holder versus adhesive tape on reducing the ETT movement. The authors reported that nearly one-third of the participants in the adhesive tape group experienced ETT slippage > 4 cm^2 (P <0.001).

Concerning the ETT slippage at 60 and 120 minutes between the two studied groups, the findings of the current study revealed that the vast majority of the participants in the Twill group had no slippage compared with nearly half of the participants in the adhesive tape group who had slippage with highly statistically significant differences *(*$P < 0.001$). This could be because the adhesive tape peeled off on its own within 30 minutes of wetting with salivation, and lost most of its adhesiveness. However, the Twill technique requires more force for slippage (Nagarajappa, Kaur, Samanta, & Tyagi, 2019). These findings are in agreement with the results of the study conducted by Walters, E.Young, and Young (2018) who reported that the Twill technique provided stabilization for the ETT and significantly lessened tube movement than the adhesive tape technique ($P < 0.001$).

Our findings are also harmonious with other similar research studies which revealed that the knot applied by the Twill technique on the ETT provides maximum fixation of the ETT with less chance for its movement from the trachea than other commercial and traditional methods (Fisher, Chenelle, Marchese, Kratohvil, & Kacmarek, 2014; Meyer, Bachmann, Lädermann, Lajtai, & Jentzsch, 2018; Rothaug, Müller-Wolff, Kaltwasser, Dubb, & Hermes, 2013; Smith & Pietrantonio, 2016;

Walters, E.Young, & Young, 2018). The previous studies also confirmed that the Twill is the best technique for securing the ETT as it ensures maximum airway security with minimal risk of unwanted movement or unplanned extubation.

Concerning the comparison of OAGs between the two studied groups, the findings of the current study noted that the severity of oral mucositis was increased among the adhesive tape group than the Twill group during two periods of times; after 12 and 24 hours from the fixation of the ETT. However, there were no statistically significant differences between the two groups after 2 or 6 hours from the fixation of the ETT. This could be because the effect of MV attachment devices appears after several hours, days, or weeks (Mohmmed & Hassan, 2015). These findings are consistent with the results of another study which reported that the oral mucosa was assessed by the nurses from one shift to another during the routine care of critically ill patients (Landsperger et al., 2019).

Kupas, Kauffman, and Wang (2010) illustrated that the ETT fixation with adhesive tapes might destroy the oral mucous membrane and lips, especially at the corner of the mouth after 12 hours. Therefore, it is necessary to assess the oral mucous integrity shift-by-shift to identify lesions and provide rapid intervention. Also, another investigation reported that critically ill patients were more likely to develop a pressure injury 2.4 times than other patients related to many artificial medical devices attached to them (Coyer, Stotts, and Blackman, 2014).

In the same line, Hyzy, Manaker, and Finlay (2017) suggested that the adhesive tape could result in mucositis and skin tears in elderly patients because they have fragile skin. These findings are consistent with the findings of the current study because most of the study sample was elderly patients. Hence, the ETT should also be rotated from one side to the other side daily to avoid pressure-induced ulceration at the lip, face, and cheek. Until, the constant re-taping can weaken the stability of the ETT and increase the chance of oral mucositis if the tape needs to be replaced when loses its adhesive properties (Coyer et al., 2014).

Moreover, a study implemented by Mohmmed and Hassan (2015) revealed that more than three-quarters of patients in the Twill group had healthy oral mucosa at 24 hours after the fixation method compared with one-third of patients in the adhesive tape group. They also claimed that the pressure on the lips caused by the unsupported weight of ETT applied with adhesive tape could damage lip microcirculation and result in a pressure area on the oral mucosa.

Also, the findings of the study conducted by Rothaug, Müller-Wolff, Kaltwasser, Dubb, and Hermes (2013) illustrated that the Twill technique was more effective and enables the provision of oral hygiene for orally intubated patients. Thus, patients with the Twill tape technique had healthier oral mucosa than the adhesive tape technique. This could be because the adhesive tape loses easily due to routine nursing care such as suctioning, rotation, and caring for the MV circuit. Furthermore, the adhesive tape can be loose easily due to the weight of the MV circuit (Hyzy et al., 2017).

On the contrary, Aydogan and Kaya (2017) reported that adhesive tape is more effective than other ETT securement techniques because it is associated with less oral mucosa injury and lip breakdown during impeding mouth care. This discrepancy could be related to the study setting as their study used the adhesive tape for fixation of the ETT in the operating room and the time of surgery is short for the adhesive tape to cause an effect on the participants' oral mucosa.

Finally, the findings of the current study showed that the Twill technique was effective for fixation of the ETT in adult ICU. Yet, there is a need for further strong evidence to support the use of this approach in different settings and with different patients. Critically ill patients require maximum efforts from nurse researchers to further investigate this area to provide evidence that ensures the superiority of the Twill technique.

6.Limitations

The PI faced many challenges during the data collection period due to the COVID-19 pandemic. Besides, the small sample size and carrying out of the study in one ICU limited the generalizability of the research findings.

7.Conclusion and Recommendations

Based upon the findings of the current study, the Twill technique is more effective in securing the ETT and maintaining the integrity of the oral mucous membrane among critically ill patients than the adhesive tape technique. Therefore it is recommended to be used in the ICUs for effective management during ETT routine care and prevention of slippage and its complications. Further large-scale studies are needed to strengthen the evidence that supports the use of the Twill technique.

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9.Declaration of Conflicting Interests

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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