Effect of Stabilizing Endotracheal Tube on Quality of Airway Management in Patients Hospitalized in ICU

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ABSTRACT

Background: The unplanned departure of endotracheal tube is one of the main complications for endotracheal intubation. In addition to endotracheal extubation, its movement can also lead to damage to the oral cavity. Stabilizing endotracheal tube is the most important factor that can prevent unplanned departure of endotracheal tube as well as its movement. The current study was done with the aim of determining and comparing the effect of stabilizing endotracheal tube by a holder with routine method on quality of airway care in patients hospitalized in ICU.

Methods: This study was a quasi-experimental trial with a control group which was done on 100 patients having endotracheal tube attached to mechanical ventilation by a holder. The samples were selected randomly from patients hospitalized in ICU in Hazrat Rasoul Akram hospital. The samples were then divided into control group and test group. The endotracheal tube was stabilized by a holder in test group and by a routine method (gauze) in control group. The quality of managing airway was studied through 3 frequency indices: endotracheal tube extubation, frequency of linear movement of endotracheal tube, damage to oral mucosa. For the first two indices a self-designed tool was used and a modified version of Oral Assessment guide was used for the oral trauma assessment. The data were analyzed using descriptive statistics, chi-square test and independent t-test by SPSS version 17.

Results: The findings showed no significant statistical difference in frequency index of endotracheal extubation. Linear movement of endotracheal tube was lower in test group compared to control group. There was no significant difference regarding oral trauma in both groups. A difference was observed in both groups in comparing scores before and after using two methods in "lips" and "Gingiva".

Conclusion: According to the results of this study, it was indicated that using ETT holder for stabilizing endotracheal tube compared to routine method only has preference in movement of endotracheal tube on quality of airway management. While applying methods of stabilizing endotracheal tube, it should be noted that not only type of stabilizing, but also other nursing cares from patients in ICU can affect quality of airway management. Therefore, it is recommended to do further studies on other factors influencing airway management.

Keywords:
Stabilizing endotracheal tube, Airway care, ETT holder

1. Background

Endotracheal tube is used as one of the methods for artificial airway, maintaining airway and also as aid for cleaning secretions and facilitating ventilation (Kapadia et al. 2000; Grap et al. 2002). In ICU, airway management is duty of nurses and respiratory care specialists. (Richmond et al. 2004) The members of treatment team are obliged to attempt as much as they can to provide care for these patients (Levy et al. 1993)

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For most of the patients, the endotracheal tube is inserted and removed according to a specific plan, and weaning patients from mechanical ventilation is programmed by the treatment group. Accidental extubation of endotracheal tube may be done due to patient's unrest or agitation during his movement for special care (Kapadia et al. 2000; Curry et al. 2008). Unplanned extubation of endotracheal tube is a serious complication of this method. The probability of endotracheal extubation is one of the concerns of treatment group. Due to this fact, the treatment team may apply different methods to decrease the emergence of this problem (Richmond et al. 2004). Furthermore, unplanned extubation of endotracheal tube is considered as one of the indices for assessing care quality of patients hospitalized in ICU (Chang et al. 2008).

The endotracheal tube must always be stabilized in its place completely so that the favorable ventilation is established and movement and unplanned extubation is prevented. Movement of endotracheal tube is the main reason for airway injury. If the endotracheal tube is stabilized improperly, other implications such as destruction of tissues of facial skin and oral mucosa may occur (Levy et al. 1993). Some researchers have recommended use of physical restraint and sedative drugs in order to decrease unplanned extubation, while others believe that use of physical restraint will increase patient's anxiety and thus probable increase of endotracheal extubation. Although different type of restraints have been used, the endotracheal extubation occurs by patient himself (self-extubation). The percentage of endotracheal extubation in patients who used restraints is 22.6%–80.

Application of sedative drugs in patients is considered as chemical restraining methods. But since thorough this method the patient needs the mechanical ventilation for a more period and it is probable that paradoxical effect of drugs followed by agitation occur, therefore, the method itself will result in unplanned extubation. Physical restraint is also another type of restraining and the first choice in patients who are more probable to experience self-extubation. However, the effect of this method on occurrence of this problem in not obvious (Chang et al. 2008). These two factors, i.e. use of intravenous sedative drugs as well as physical restraint are among the influencing factors on endotracheal extubation. Some standards have been determined for their application, but manner of stabilizing endotracheal tube has always been the troublesome factor (Grap et al. 2002). The nurses have used several methods for stabilizing the endotracheal tube so as to open the patient's airway and decrease extubation complications (Levy et al. 1993). Personnel of each ward use different methods for this purpose (Richmond et al. 2004).

The stabilization methods can be divided into 4 categories First is the sticking method through which the endotracheal tube is attached to the patient with a stick. The second method is gauze, in this method first the gauze is tied over endotracheal tube and then around patient's neck. The third method is using a holder. This holder includes the commercial type or the type which is devised for patient using hospital tools with hand. And finally there are methods which are applied in certain cases such as facial burns, fractures and oral & maxillofacial surgeries (Lovett et al. 2006). The first two methods, i.e. stich and gauze have been used more up to now (Levy et al. 1993; Lovett et al. 2006).

In addition to the above mentioned studies, some studies have been carried out in order to compare different types of commercial instruments with each other and their comparison with sticks. But these studies are few. Commercial stabilizer are used in few patients. According to the calculations of producing companies, around 13 to 20 million endotracheal intubation have been reported in America in 2003. In emergency departments and ICU about 3 million endotracheal tubes are purchased annually, but the demand market for commercial instruments of ETT holder is about 500000 pieces every year (Levy et al. 1993). The gauze is used for stabilization in more than half of the patients with endotracheal tube (Lovett et al. 2006).

The ideal method for stabilizing the endotracheal method is the one which decreases its movement and provides a convenience situation for patient. It is also important to maintain oral health and skin integrity while using it. The manner of using the intended method should be easy and minimum time should be spent. Although, there are many studies regarding the complications of endotracheal extubation or complications concerning improper stabilizing, neither of these studies have compared relation between rate of occurrence of these complications and the method used for endotracheal extubation (Levy et al. 1993). This research seeks to introduce a new method, i.e. using ETT holder, to nurses and ICU clinicians, it also tries to emphasis on ETT care and managing airway by using endotracheal stabilization method so as to help nurses to provide proper care for patients in ICU with artificial airway. Therefore, the researcher decided to compare the effects of using ETT holder on quality of airway management with routine method.

2. Materials & Methods

This study was a quasi-experimental trial with a control group which aimed to determine and compare the effect of endotracheal stabilization by a holder and stabilizing by a routine method on quality of airway management. The statistical population included the patients who had orotracheal & nasotracheal tube and mechanical ventilation hospitalized in surgical ward & ICU in Hazrat Rasoul Akram hospital. Data gathering were done through homogenization. In this manner, the researcher personally attended Hazrat Rasoul Akram hospital complex on different days of week in morning, evening and night shifts. The qualified patients for sampling were selected since the first day of hospitalization. In order to determine the method for stabilization of patients, the method changed every other day for each patient. After sampling, the samples were homogenized in both groups in terms of individual indices. In the test group, stabilization was performed by ETT holder and in the control group it was done by a gauze method (routine method). After the intervention, the research variables were examined in both groups. The sampling totally lasted 3 months. The inclusion criteria for samples was patients with oropharyngeal airway under mechanical ventilation. The oral consent pf physician was taken for placement of the holder. It should be mentioned that the inclusion criteria was previous oral injury for any reason and changing stabilization method during intervention period before the 1st 48 hours.

In this research the tool for data gathering was data sheet for registering information. The researcher and her colleagues completed the paper. This paper consisted of three parts: The first part covered individual characteristic of the patients who were being studied (patient's code, age, sex, disease diagnosis, date and hospitalization ward, date of intubation, type of stabilization, level of consciousness according to GCS, use of physical restraint, (taking sedative drugs); the second part was related to care indices and included:

A- The form for data gathering of endotracheal tube movement: the invariable of endotracheal tube movement was investigated after the first stabilization of endotracheal tube, the length endotracheal tube was measured from the edge of patient's incisors to outer end of endotracheal tube. The measurement was registered in mm in a specific place and was named length of base. Then every 12 hours (2 times a day) the length was remeasured and written down. At the end, all measures were compared to length of the base. After the comparison, the difference between these two figures was written down as absolute value and at the end of the intervention, these figures were summed up. The result of these calculations showed endotracheal tube movement. The measurements were done at morning shifts and at nights before correcting place of tube by the nurse.

B- Self-designed tools for investigating endotracheal extubation: in the case of extubation during the intervention, type of extubation (unplanned extubation: self-extubation or accidental extubation or end of treatment or reasons such as tube replacement) was registered in data gathering form by the researcher or her assistant in the working shift in which it was extubated.

C- Tool of "Oral assessment guide": oral injury was measured by "Oral assessment guide". This guide was designed by Burger & Peterson in 1988 and its validity was assessed once more by Gibson and his colleagues in 2006. The lips, corner of the lips, tongue, gingiva, oral mucosa and salvia were studied thorough this tool. Since the patients had problem in swallowing and speaking due to endotracheal tube, therefore, these two parts were omitted from main tools. Mouth was studied once at the beginning of intubation, and the score obtained was considered as base figure, and once at the end of the intervention. Two scores were compared and their difference was regarded as oral injury.

In this research, the quality of airway management included maintaining safety of patient's airway and indices determining quality of airway based on care results. These indices consisted of frequency of endotracheal extubation, endotracheal movement and mouth injury.

Having obtained the necessary license from Faculty of Nursing & Midwifery, Iran University of Medical Sciences, the researcher attended research department and she started teaching the nurses how to use ETT holder after obtaining consent of authorities of hospital and wards as well as physicians taking care of the patient. The researcher offered these trainings within each ward during 10 minutes at the end of patient's round. The researcher explanations were with the help of device translated brochure in Persian and by the image explaining how to use the device. Then, it was shown practically on the maquette and every nurse was forced to use the device correctly on the maquette at least once. If they failed, the training continued until they learned how to use the device properly.

The ETT holder (Grip-ET) is a plastic instrument which consists of 5 parts. The blue part covers patient's mouth, the green part is fastened around endotracheal tube. There are tracks inside the green part which prohibit endotracheal slip and movement. The red part is

Table 1. Frequency distribution of samples in both test and control group based on endotracheal extubation (n=100).

Group / Endotracheal extubation	Test		Control	
	frequency	Percentage	frequency	Percentage
*Unplanned extubation	6	12	5	10
**Other	44	88	45	90
Total	50	100	50	100
Statistical test	X^2=0.102 P=0.749 df=1			

*Unplanned extubation includes self- extubation and accidental extubation.
**Other includes end of treatment or tube replacement.
In this Table the self-extubation and accidental extubation parts were merged because they were few.

Client-Centered Nursing Care

the device log and fastens the green part in manner that it can't move at all. The green part is attached to the blue part body with rubber band and it can be released by pressing the two ends of the green part after opening the lock. The last part is a strip which swings around patient's neck. This strip is made of anti-sensitive fibers which are glue-like at ends and are attached to two edges of blue part.

The research samples were studied from the beginning of endotracheal intubation. Since the researcher needed to be present 24 hours to complete the report registration paper and this was impossible for her, therefore she selected three nurses (in charge of every working shift) as colleague. She explained them objectives of research and obtained their consent as well, then they received the required trainings regarding completion of the paper so as to help the researcher to complete the tools. These nurses also registered data of study. The researcher and her colleagues examined the patient's intended variables 2 days at minimum and 7 days at maximum after the first day of intubation and the gathered data using intended tools. The researcher obtained the written consent of the patient (in case he is fully conscious) or his attendant before intervention. The method of stabilization changed for every other patients who were studied. 100 samples who had similar individual particulars were statistically studied and other samples were omitted. At first, the researcher or her assistants registered the patients' particulars in a paper designed for it. Then, necessary investigation were done for each variable.

At the beginning of stabilization, the length of endotracheal tube was measured in both groups by a tape from incisors up to the outer end of endotracheal tube. The obtained score was registered in mm in the specified part. This figure was named length of base. Then every 12 hours, i.e. in the morning shift before correcting place of endotracheal tube and once at the beginning of night shifts, the length was measured. This figure was compared to the length of the base and the difference between these two figures was written down. In this manner, 2 figures were written for each patient within every 24 hours. At the end of the 7-day research, the sum of these figures indicated endotracheal movement.

In the case of extubation, type of extubation (unplanned extubation: self-extubation or accidental extubation or end of treatment or other reasons) was registered in the working shift in which it was extubated.

The "Oral assessment guide" was used to study oral injury and was completed by observation. The researcher or her assistant scored the patient according to the table inserted in tool as soon as they observed oral mucosa. This tool was once completed for patients of both groups at the beginning of stabilization and the score achieved was named as base score, then the scoring was done at end of intervention. The final figure which was in fact the difference of scores in each patient indicated the oral injury resulted from each method of stabilization.

If the stabilization method changed for each patient for any reason during the treatment, the intended patient was omitted from research. In this study, the stabilization method did not change for all the patients. Furthermore, if the endotracheal tube was extubated without plan or if the patient was separated from mechanical ventilation sooner than the end of research due to improvement, doing tracheostomy or changing endotracheal tube, the patients were studied up to that time and the data were used in the research.

The descriptive statistics was used to describe the study samples. Independent t-test and chi-square test were used to compare the groups and to achieve objectives of research. The data were analyzed through single blind method. Also, the SPSS software, version 17 and statistical tests were applied for data analysis.

Table 2. comparison of average of endotracheal tube movement in both control and test group (n=100).

Linear movement (mm)	Test	Control	Independent t-test
Mean	96.13	104.25	t=2.245 P=0.027 df=98
Standard deviation	18.021	18.14	

Client-Centered Nursing Care

The restrictions of the research were: the probability for not reporting the incidents related to endotracheal tube by nurses for any reason (fear of report in case the nurse is guilty) or the probability of endotracheal tube manipulation within every 12 hours and failure in writing it down.

3. Results

The samples of research were 100 patients with endotracheal tube which was attached to mechanical ventilation. These patients were hospitalized in Surgical Intensive Care Unit (SICU) and emergency ward of Hazrat Rasoul Akram Hospital, affiliated to Iran University of Medical Sciences. The samples were equally assigned in test and control group (50 persons in each group). In the test group (0.70%) and in the control group (63%) of samples were men. Most samples in test group were 32% and in control group 34% aging more than 70 years. In the test group 48% and in the control group 54% of disease diagnosis were cases other than trauma and brain injury. The most endotracheal tube which was used in test group (44%) and in control group (44%) was tube no. 8. In both groups, most patients had the score (GCS) between 8-13 regarding the level of consciousness (in test group 54% and in control group 46%, respectively). In test group (78%) and control group (72%) most of the patients didn't have physical restraint. In test group (54%) and control group (60%) used sedative drugs.

The research was carried out at Surgical Intensive Care Unit (SICU) and emergency ward of Hazrat Rasoul Akram Hospital, affiliated to Iran University of Medical Sciences. Each of these wards had 12 beds. Beside each bed, there was a mechanical ventilation which was used if required. One nurse was in charge of every 2-3 beds on every working shift. The nurse was also responsible for the airway management. At beginning of each working shift and before leaving the ward, the patients were checked in case they needed suction. The endotracheal tube status and the necessity for oral care (oral rinse) was also examined and if necessary, it was done. The patients' level of consciousness was measured every two hours and was written in flowchart. The oral rinse and position change was performed by ward assistant under the supervision of the relevant nurse. The patients who had physical restraint were attached to beds using special bracelet and shackle. This was done by nurse assistants. They are again opened and closed while changing patient's position and based on their manner of placement. The doctor prescribes sedative drugs needed for this stage, but four drugs are often injected: Midazolam, Pethidine, Diazepam, and Morphine. The number of intubated patients in each ward varied depending on the situation in every shift and there was not a stable number.

Comparison of effect of stabilizing endotracheal tube by ETT holder and routine method on quality of airway management (frequency of endotracheal extubation) indicate that there was no significant difference in frequency of endotracheal extubation in the test group compared to control group (Table 1). In comparison of frequency of linear movement of endotracheal tube in both test and control groups, it was observed that the average of linear movement of endotracheal tube was higher in control group (P=0.027) (Table 2). The score of oral mucosa injury was compared and measured in both groups before and after applying stabilization method. This comparison showed that there was no significant difference concerning the oral injury in both groups (Table 3).

4. Discussion

The incidence of unplanned extubation is considered as one of the assessment indices care quality in patients hospitalized in ICU (Curtis et al. 2006). The current study was carried out with the aim of determining and comparing the effect of stabilizing endotracheal tube by ETT holder and the routine method on quality of airway management in patients hospitalized at ICU at Hazrate Rasoul Akram Hospital. The comparison of effect of stabilizing endotracheal tube by ETT holder and the routine method on quality of airway management (frequency of endotracheal extubation) indicated that there was no significant difference in frequency of endotracheal extubation between the test and control groups.

In the study carried out by Loy and his colleagues in (1993), there was no significant difference in the frequency of endotracheal extubation in stabilizing endotracheal with gauze method compared to other methods. In his study, none of the patients with gauze experienced

Table 3. Comparison of average of oral injury score in both control and test group (n=100).

Oral injury	Test	Control	Independent t-test
Average	0.88	104.25	t=2.245 p=0.027 df=98
Standard deviation	1.081	18.14	

Client-Centered Nursing Care

unplanned extubation (levy & Griego 1993). In Tasota study, the probability of endotracheal extubation in device method was lower than gauze method. (P=0.008) (Tasota et al. 1987). The obtained results in the study carried out by Branson and his colleagues in 1998 under the title of "best method of stabilizing endotracheal tube", similar to the Tasota study, the ETT holder has priority over knotting method (Tasota et al. 1987).

Factors other than proper stabilization also affect endotracheal extubation. Since no significant difference was observed in the frequency of endotracheal extubation, therefore it can be stated that in the hospital besides stabilization method, other factors influencing endotracheal extubation can affect the obtained results. For example, airway care such as suction or oral rinse can have effect on movement of endotracheal tube in patients (Chiang et al. 1996). In this study, airway suctioning is done every 2-3 hours or less (if required). Suction in patients who were more conscious (8-13 GCS) caused coughs and in turn endotracheal extubation (Chiang et al. 1996). The results of the study carried out by Bozua and colleagues indicated that in five cases patients had endotracheal extubation (15%) due to coughing (Bouza 2007). In these patients, unplanned extubation can be due to cough resulting from airway suction. Therefore, it is better to decrease emergence of this incident by proper training of suction and more supervision of nurses.

In comparing the frequency of linear movement of endotracheal tube in both test group and control group, it was observed that the average of linear movement of endotracheal tube was higher in control group. In a similar study carried out by Tasota et al, (1987), it was reported that the stabilization method by ETT holder has priority over other methods in endotracheal tube movement. Linear inward and outward movement of endotracheal tube considerably decreased when using ETT holder (P>0.001) (Tasota et al. 1987). In the current study, average of frequency for linear movement of endotracheal tube was 96.13 in test group and 104.25 in control group. In the study of Kaplow and his colleagues in 1994, in 3 ETT holders, the average movement was 0.50 cm (Kaplow 1994). In the study of Kaplow, the average of endotracheal tube movement in knotting method was 2.38 cm. The result of the present study corresponds to similar studies.

In the routine method, the gauze often gets wet due to the patient's secretion and this matter causes the gauze to slip. As a result, with every movement of patient, cough or airway management, the endotracheal tube also moves. Moreover, whenever head of the patient moves or his position changes, and by suctioning, the gauze knot becomes looser. This also helps further movement of endotracheal tube (Kaplow 1994).

Using newer methods such as ETT holder device can lessen these problems. On the other hand, in comparing the frequency of endotracheal tube movement in both groups with similar studies, it was observed that the frequency of endotracheal tube movement was higher in the present study. The movement of endotracheal tube can be decreased if the nurses receive more training on importance of stabilizing endotracheal tube and training on the control of endotracheal tube length during appropriate periods and in case that they will be informed of the risks of improper stabilization.

In comparison of oral injury in both groups, the difference of injury score was measured before and after applying each method of stabilization. This comparison indicated that there was no significant difference in both groups regarding oral injury. However, in the study of Kaplow and his colleagues (1994), the ETT holder had caused the least injury in lips and facial skin. (P=0.006) .Tasota et al, (1987) and his colleagues reported that using ETT holder had considerably decreased the injury to oral mucosa and facial skin. (P=0.006). It was also observed that in both groups oral mucosa injury increased after applying both methods of stabilization. In observing oral injury before applying method and after that by using both methods, the injuries to lips, oral mucosa, tongue and salvia increased.

In patients hospitalized in ICU, following the decrease in level of body safety and presence of endotracheal tube in mouth and due to the fact that the mouth is open, the oral mucosa is exposed to injury and getting dry and change of the nature of natural mouth flora and turning into environment full of anaerobic gram-negative bac-

teria. It was also difficult to access patient's mouth due to endotracheal tube and other feeding tubes. These patients could not show proper safety responses to bacteria and this can bring about dental plaques, oral injuries as well as Pneumonia (Munro 2004).

In the current study, the test group often had the ETT holder in their mouth up to the end of treatment or study. In both parts of the study, nurse assistants were responsible for oral care. The nurses were often supervisors and most of the time due to increase in workload there was no accurate supervision.

In the hospital of study, every two hours after suctioning endotracheal tube, the mouth of all patients was suctioned. This can cause oral mucosa injury. As for the oral rinse, the researcher could not control this one too. In the gauze method, the gauzes were daily changed because the nurses had more acquaintance with them and it was easy to use them. But there was often no standard method for dressing. The knots often caused the gauze to be stretched excessively and to press the lip corners. This will increase the oral injury. The mouth of these patients was often open which caused dryness and decrease in salvia secretion. This matter increased score of injury in "salvia", "tongue", "oral mucosa" and "gingiva".

However, there was an observable difference in comparison of oral injury in both groups, but the test group suffered from less injury in "lip" & "gingiva". The reason is that the endotracheal tube keeps the mouth open and as a result, the tongue gets dry but in the test group the ETT holder covers the mouth in a manner that decreases its openness. In the control group, the gauze cannot cover the mouth the same as ETT holder. Therefore, the oral injury may have increased due to this fact. In addition, the ETT holder is designed in a way that the internal piece is placed over the gingiva and protect it against injuries which may occur during suction. In the control group, the gingiva suffered from higher injuries as the gauze could not protect them.

Off course, it should be mentioned that oral care is regarded as a part of nursing care, but in this study the nurse assistants were responsible for oral care and changing position, because the number of patients were more than nurses (4-5 patients for each nurse) while the care standard in ICU is 1-2 patients for each nurse (Brilli et al, 2001) and there were few nurses with too much workload which was not based on the world standards. If oral cares were completely done by the nurses or if the nurse assistants had received more training on proper performance of oral cares, we may had different results.

Therefore, considering the issues discussed above and the results of the study, it should be noted that while applying methods of endotracheal stabilization, not only the type of stabilization but also other nursing cares in ICU can affect quality of airway management. Furthermore, more modern methods can cause anxiety in nurses and it is better to spend more time in training newer methods. Supervision on non-specialized forces in similar treatment centers where there are shortage of nursing specialized force is among the cases which should be considered seriously.

Finally, it can be concluded that in this research, using ETT holder for stabilizing endotracheal tube compared to the routine method had only priority in case of endotracheal movement on care quality.

In care quality of patients hospitalized in ICU, i.e. the point of emphasis in this research, the important issues are who cares the patients and where there are cared. Differences such as these may cause dissimilar "results" or "outcomes". (Donabedian 2005) Therefore, factors other than method of stabilizing endotracheal tube can affect quality of airway management.

Conflict of interest

The authors declare that they have no conflict of interest.

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