Physical Factors Affecting Success Rate During Endotracheal Intubation

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Physical Factors Affecting Success Rate During Endotracheal Intubation

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[Abstract]

In this paper, We propose the purpose the examine the physical factors that influence the success rate during the endotracheal intubation and to provide the basic data for effective intubation success. The subject of this study was 42 students in emergency rescue department who had completed the BLS Health Care-provider and a specialized airway maintenance course dealing with endotracheal intubation and it is a similar experimental study after the non-equivalence single group. For data analysis, SPSS 23.0 Version was used. The study methods were measuring the grip fotce of subjects, the angle of arm during intubation tube, distance from manikin, palm length, etc. The results showed that there was a correlation between the time of successful endotracheal intubation and the physical characteristics. In particular, when performing endotracheal intubation, it was related to the angle of the arm and the execution time of the performer, and the narrower the angle of the arm, the shorter the execution time. The results of this study suggest that successful endotracheal intubation could be implemented if the operator tried to reduce the angle of the arm when performing endotracheal intubation, and through further research on various job groups, identify the possibility of clinical use will be necessary.

▸ **Key words**: Endotracheal intubation, Advanced airway management, Airway management, Physical factor, Angle of the arms

[요 약]

본 연구는 기관 내 삽관 수행 시 성공률에 영향을 미치는 신체적 요인에 대해 알아보기 위한 비동등성 단일군 사후 유사 실험연구이다. 연구결과 기관 내 삽관을 성공적으로 수행한 시간과 신체적 요인은 상관관계가 있는 것으로 나타났다. 특히 기관 내 삽관 수행 시 수행자의 팔의 각도는 수행시간에 영향을 미쳤으며, 팔의 각도가 좁아질수록 수행시간이 짧아지는 결과를 보였다. 기관 내 삽관 수행 시 수행자의 팔의 각도를 줄일 수 있도록 노력한다면 성공적인 기관 내 삽관을 시행할 수 있을 것이다. 하지만 다양한 환경 및 직군에 대한 추가적인 후속 연구를 통해 임상적 활용의 가능성을 확인해야 할 것이다.

▸ **주제어**: 기관 내 삽관, 전문기도유지술, 기도관리, 신체적 요인, 팔의 각도

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I. Introduction

Airway management is a very important factor affecting the life and prognosis of emergency patients[1]. Endotracheal intubation, one of the advanced airway maintenance equipment used to secure and maintain the airways, is used to close the upper airway caused by strictures, edema or foreign objects in the trachea, or used to maintain breathing in case of difficulty in breathing due to trauma to face or chest[1,2]. Endotracheal intubation is one of the doctor's tasks, and a first-class emergency medical technician is also one of the tasks that can be performed from the pre-hospital stage for airway maintenance and respiratory treatment[3]. This endotracheal intubation is very important because it requires the second highest level of medical guidance among first-class emergency medical personnel, and it is a device that requires the use of specialized skills[4]. In fact, according to the 2013 Annual Report on 119 Emergency Services, 773 cases of endotracheal intubation were reported out of the total of 633,807 treatments related to securing airway in that year, and only 0.1% of the cases were performed.[5].

Endotracheal intubation is a technique that inserts a tube into the oral cavity to maintain the airway, and is the best instrument to be performed to patients in need of airway management, and it has the advantage of being able to deliver accurate tidal volume to the lungs[1]. However, if the endotracheal intubation is repeated several times or the intubation fails, the prognosis of the patient is adversely affected[6-8]. Therefore, in order to successfully perform endotracheal intubation, it is necessary to be aware of the necessity of endotracheal intubation, to determine the best intubation method. And if necessary, use a variety of alternative equipment or require a constant and high skill in the equipment[9].

Previous studies related to this study have been conducted to increase the success rate of endotracheal intubation, and most of the studies use equipment that can change equipment or replace endotracheal intubation.

The endotracheal intubation was performed by changing the laryngoscope blade and attaching a video camera to the laryngoscope blade to view the image of airway structure on the LCD screen. As a result, cervical spine movement was less than that of the conventional direct laryngoscope. In particular, it was concluded that trauma patients suspected of cervical vertebral injury have an advantage over laryngoscope[10-13]. In addition, there has been a growing interest in supraglottic airway devices that can replace endotracheal intubation for faster and more accurate breathing of emergency patients in pre-hospital situations. Accordingly, light wand, laryngeal mask airway, LMA, King laryngal tube, Flexible bronchoscopes, video laryngoscopes, etc. have been studied[14-17].

In the meantime, in order to increase the success rate of endotracheal intubation and to support and maintain the professional breathing of patients, various studies at home and abroad have been conducted. However, there have been no studies on the physical characteristics of the performer, which is the basis for performing endotracheal intubation. The purpose of this study was to investigate the physical factors that influence the success rate of endotracheal intubation and to provide basic data for effective endotracheal intubation.

II. Methodology

1. Study design

This study is to investigate the physical factors that influence the success rate during endotracheal intubation, and a postmortem study of inequality single-group trials to compare the physical factors of the performer with the results of endotracheal intubation by using the airway management manikin.

2. Study Object

The subjects of this study were 42 students in 4th grade in the Department of Emergency Rescue in N University of C region. Preliminary experiments were conducted prior to this experiment, and the number of subjects was selected by using G*Power 3.1. The effective size was 40 students who applied 80% power at the 0.05 significance level, and the final 42 students were selected in consideration of the omissions due to errors that may occur during the experiment.

The selection conditions for the test were: First, those who took specialized airway maintenance courses dealing with endotracheal intubation of emergency patients, Second, those who have completed the BLS Health Care-Provider, which is certified by the American Heart Association(AHA) and the Korean Association of Cardiopulmonary Resuscitation(KACPR), Third, those who understand the purpose of this study and agree in writing. In order to reduce the distortion of physical factors during endotracheal intubation, the experiment was conducted by a researcher alone.

3. Data Collection and Tool

3.1 Survey Tool

The general characteristics(gender, age, height, weight) of the subjects were collected by self-report form through questionnaires and measurements.

3.2 Measurement of physical characteristics during endotracheal intubation

The grip strength of the subjects who participated in this study was measured twice by dividing into 1st and 2nd, and it was defined as the subject's grip strength, which was the average grip strength obtained by averaging the two measurements. The angle of the subject's arm was measured by taking a picture of the laryngoscope at the end of tracheal intubation of the manikin's mouth and drawing imaginary line of wrists and elbows, elbows and shoulders, each inner angle was measured. In addition, the distance between the subject and the manikin was measured by drawing an imaginary line of the linear distance between the subject's forehead and the manikin's head. The performance time of endotracheal intubation was defined from the beginning of laryngoscope intubation, which is used to perform endotracheal intubation, and to the time of the assembly of Bag-Valve-Mask was after the end of endotracheal intubation. The length of the subject's hand was measured from the wrinkles close to the palm of the wrist to the tip of the middle finger with the hand straight to the tip of the finger, the palm length was measured from the wrinkles close to the palm of the wrist to the beginning of the middle finger in the same state as when measuring the length of the hand.

Fig. 1. Manikin for Endotracheal Intubation

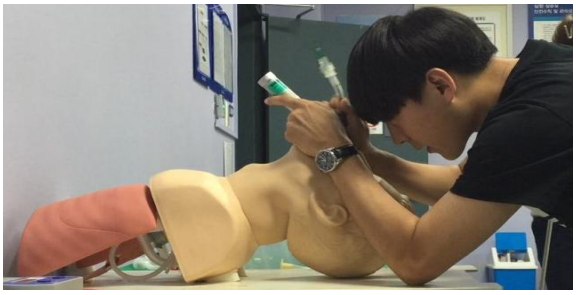

Fig. 2. Posture in Endotracheal Intubation

4. Data Analysis

The collected data was were analyzed using a SPSS Ver. 23.0 for Win statistical program. The sex, age, height(cm), weight(kg), grip(kg), and arm angle(°) of the subjects were calculated as the mean and standard deviation, and the Paired t-test was used to compare the two groups (Height, weight, grip, arm angle, distance from manikin, hand, palm length, performance time) according to gender. Pearson correlation coefficient was used to

correlate physical and arm characteristics, and multiple regression analysis was used as an influential factor during the intubation. The significance level of all analyzes was set to 0.05.

III. Results

1. General characteristics of subjects

Among the total 42 subjects, 18(42.9%) were male, 24(57.1%) were female. The age was 21.90±1.26 years old, average height was 168.15±9.12 cm, and average body weight was 61.21±12.99 kg. The mean grip strength was 33.91±10.27 kg and the average arm angle was 98.83±9.66 °[Table 1].

Table 1. General characteristics of the subjects

Characteristics	Category	N(%)/M±SD
Gender	Male	18(42.9)
	Female	24(57.1)
Age(year)	21.90±1.26	
Height(cm)	168.15±9.12	
Weight(kg)	61.21±12.99	
Grip strength(kg)	33.91±10.27	
Arm angle(°)	98.83±9.66	

2. Comparison of physical characteristics according to gender during endotracheal intubation

Table 2 shows the results of comparing body characteristics(height, weight, grip strength, arm angle, distance from manikin, hand length, palm length, and performance time) according to gender and posture during intubation. The height, weight and grip strength according to gender were significantly different in men and women(p<.001). When performing endotracheal intubation the arm angle also significantly different according to gender(p<.001), and the distance from manikin was also significant(p<.001). In addition, hand length and palm length showed significant differences according to gender (p<.001), and the time taken for endotracheal intubation was also statistically significant(p<.001)[Table 2].

3. Correlation of physical factors during the endotracheal intubation

As a result of comparing the physical characteristics of the study subjects and the characteristics of the arm during the endotracheal intubation, there were correlations in both the characteristics of the arm according to the physical characteristics. The angle of the arm showed negative correlation in height(r=-0.74), weight(r=-0.74), grip strength(r=-0.83) and positive correlation(r=0.84) with performance time. The distance from manikin was positively correlated with height(r=0.58), weight(r=0.53), grip strength(r=0.44) and negatively correlated with performance time(r=-0.47). The subjects' hands showed a positive correlation in height(r=0.89), weight(r=0.89), and grip strength(r=0.82), and negatively correlated with performance time(r=-0.77). The palm length of subjects showed positive correlation in height(r=0.82), weight(r=0.75), and grip strength(r=0.66), and negative correlation with performance time(r=-0.61).

The palm length of the subjects showed positive correlations in height(r=0.82), weight(r=0.75), grip strength(r=0.66), and negative correlations with performance time(r=-0.61)[Table 3].

Table 2. Differences in physical characteristics by gender during endotracheal intubation

	Total	Male	Female	p
Height (cm)	168.15± 9.12	176.18± 5.64	162.13± 6.06	<0.001
Weight (kg)	61.21 ±12.99	72.50 ±9.82	52.75 ±7.42	<0.001
Grip strength(kg)	33.91 ±10.27	43.44 ±7.05	26.76 ±5.20	<0.001
Arm angle (°)	98.83 ±9.66	90.73 ±3.59	104.90± 8.18	<0.001
Distance to manikin(cm)	47.58 ±7.95	52.10 ±6.59	44.18 ±7.64	<0.001
Hand length (cm)	17.58 ±1.21	18.58 ±0.78	16.83 ±0.89	<0.001
Palm length (cm)	9.93 ±0.76	10.45 ±0.59	9.55 ±0.64	<0.001
performance time(sec)	24.11 ±4.64	19.80 ±1.66	27.26 ±3.91	<0.001

Table 3. Correlation of physical factors during the endotracheal intubation

	Arm angle		Distance		Hand length		Palm length	
	r	p	r	p	r	p	r	p
Height(cm)	-0.74	<0.001	0.58	<0.001	0.89	<0.001	0.82	<0.001
Weight(kg)	-0.74	<0.001	0.53	<0.001	0.89	<0.001	0.75	<0.001
Grip strength(kg)	-0.83	<0.001	0.44	0.003	0.82	<0.001	0.66	<0.001
performance time(sec)	0.84	<0.001	-0.47	0.002	-0.77	<0.001	-0.61	<0.001

Table 4. Correlation of physical factors during the endotracheal intubation

	Arm angle		Distance		Hand length		Palm length	
	β	p	β	p	β	p	β	p
Gender	1.45	0.624	-2.97	0.441	0.16	0.564	0.21	0.425
Height	-0.18	0.414	0.40	0.172	0.05	0.012	0.06	0.001
Weight	0.03	0.862	0.10	0.632	0.03	0.049	0.01	0.809
Grip strength	-0.25	0.294	-0.38	0.216	0.01	0.696	0.01	0.935
performance time	0.88	0.029	-0.47	0.351	-0.03	0.369	-0.01	0.910
	R2=0.749 p<0.001		R2=0.374 p<0.004		R2=0.845 p<0.001		R2=0.679 p<0.001	

4. Physical factors affecting endotracheal intubation

As a result of analyzing the physical factors influencing the endotracheal intubation, the greater the angle of the manikin and rescuer's arm during endotracheal intubation(β=0.88, p<0.029), the execution time was significantly increased(R2=0.749, p<0.001), distance between the manikin and the performer did not affect. When during the endotracheal intubation, the length of the rescuer's hand, the larger the height(β=0.05, p=0.012), the longer the length of the hand, and the longer the weight(β=0.03, p<0.049), the longer the length of the hand(R2=0.845, p<0.001). When during the endotracheal intubation, the length of the rescuer's palm, the larger the height(β=0.06, p<0.001) and it also lager (R2=0.679, p<0.001)[Table 4].

IV. Discussion

Endotracheal intubation is recognized as the best ventilation aid[18], and fast and accurate endotracheal intubation is an important device for securing the patient's airways and maintaining breathing. Repeated endotracheal intubation consumes the rescuer's strength and increases the arm's strength[11], and if the rescuer's strength is strong, it may be beneficial to increase the success rate in performing endotracheal intubation.

As a result of this study, there were differences in the physical characteristics according to the gender of the study participants and the degree of endotracheal intubation. Males had higher height, weight and grip force than females, and the angle of endotracheal intubation was narrower than females. The linear distance between the forehead of the study subjects and manikin head was longer in males than in females, and the hand length and palm length were longer in males than in females.

The performance time of endotracheal intubation was shorter in males than in females. Side effects of endotracheal intubation may include thermogram in the lips or tongue, damage to the teeth, thermogram in pharynx or tracheal mucosa, and rupture of the trachea can be occurred[19], In general, the higher the grip and the larger the hand, the more advantageous it can be to successfully perform endotracheal intubation. In general, the higher the grip and the larger the hand, can be more to successfully perform endotracheal intubation. According to the National Examination Protocol of the first-class emergency medical technicians, the performance time of

endotracheal intubation is limited to 30 seconds, if the first attempt is unsuccessful, it is required to perform a second endotracheal intubation after a recirculation with 100% high concentration oxygen[20]. According to the results of this study, the endotracheal intubation was successful within 30 seconds for both males and females suggested in the first-aid paramedical protocol, but males performed significantly faster than females. If the subjects' proficiency is assumed to be the same, this difference is considered to be the result of differences in male and female power. Therefore, all doctors and first-class emergency medical personnel should improve their physical strength regardless of gender so that they can provide appropriate first aid when the patient needs to maintain breathing in the real field.

During the endotracheal intubation, the angle of arm was negatively correlated with grip strength. In previous studies, as the angle of the arm increased, the result was consistent with the decrease in grip strength[21-23]. Also, the narrower the angle of the arm, the shorter the time for endotracheal intubation. This means that the closer the position is to the height of the patient, the narrower the angle of the arm. Thus, in the study of Takenaka et al.[24] and Shim[25] shows similar result that the lower the height of the endotracheal intubation, the faster the endotracheal intubation. Therefore, when performing endotracheal intubation, the angle of the arm of the performer should be narrowed to increase the grip strength, and thus the endotracheal intubation to the patient can be easily performed and the success rate also can be increased.

In addition, the study showed the same results with the study that the performer's weight, height, hand size were related with the grip strength[26, 27]. Therefore, it is necessary to consider the method of changing the size of the laryngoscope for successful endotracheal intubation. The limitation of this study is that the study was conducted on manikin and not on patients in actual clinical trials. Therefore, further studies are needed that include the characteristics of the patient. In addition, muscle strength may vary depending on the age of the performer, so to implement this, the follow-up studies on various age groups and occupational groups of the subjects will be required.

V. Conclusions

Based on the results of this study, it was found that in order to successfully perform endotracheal intubation, it was related to performance time and physical characteristics. In particular, there was a relationship between the angle of the arm and the endotracheal intubation time. As a result, the narrower the angle of the arm, the shorter the performance time. Thus, if efforts are made to reduce the angle of the arm during performance, successful endotracheal intubation may be performed. However, physical factors are subjective tendencies and various factors that can change. Therefore, through additional research on various job groups that can be done as an endotracheal intubation, it will be necessary to identify the possibility of clinical use.

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