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TANAFFOS

Presentation of Two Simple Methods to Confirm Proper Tracheal Intubation: Palm Pressure, Plastic Bag Inflation, and Bag Pulsation

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Background: The correct placement of the endotracheal tube is a cornerstone of safe anesthesia. Different methods, such as auscultation, capnography, and ultrasound, have their own limitations regarding the confirmation of endotracheal intubation, reinforcing the idea that a single technique is not foolproof. This study proposes a new technique in this regard.
Materials and Methods: A total of 600 patients were enrolled in this study, and tracheal intubation was checked with palm pressure and disposable plastic glove inflation and pulsation.
Results: The data were analyzed using the t-test and Mann-Whitney U test that indicate 94% and 94.8% sensitivity for palm pressure and bag pulsation, respectively, and a 100% positive predictive value for both tests.
Conclusion: Palm pressure and bag pulsation are accurate, inexpensive, and reliable techniques to confirm proper tracheal intubation.

Key words: Tracheal intubation; Palm pressure; Bag inflation; Bag pulsation

INTRODUCTION

Tracheal intubation is a daily task for anesthesiologists, whether it is difficult or not. The tube's proper position in the trachea or inadvertent esophageal intubation should be checked after each attempt. A handful of methods are being used for this vital check, and their efficacy has been evaluated, such as auscultation, esophageal detector devices (EDDs), X-ray study, capnography, fiber optics, and ultrasound. Based on the available data, no single method is 100% specific and 100% sensitive. The oldest methods are auscultation and EDDs. Although auscultation is available, simple, and inexpensive and does not require special expertise, it might be misleading in obese patients (1). Likewise, EDDs are simple, inexpensive, and easy to use but might be inaccurate in obese patients (2) or cause occlusion (3).

Capnography is available at theatres but not in all emergency departments or intensive care units (4). Although it is useful in operating theatres, it could not be as useful during low perfusion states, such as cardiopulmonary resuscitation (5). Fiber optic devices might not be available in emergency departments and are time-consuming. Ultrasound is a more recent technique presented for the confirmation of tracheal intubation. It is complicated and needs special expertise to be used (5). Some other techniques, such as tactile laryngeal maneuver, have been proposed to assess proper tracheal intubation in emergency settings which further advanced the insight into confirming the correct placement of the endotracheal tube (6).

No single method is ideal for the purpose of this study; therefore, authorities recommend a multimethod approach to increase the accuracy and efficacy of the check and patient safety. This study proposed a novel technique of palm pressure on the chest wall that is simple, inexpensive, and specific that requires neither complicated devices nor skilled staff.

MATERIALS AND METHODS

During 12 months, all non-traumatic adult patients not suffering rib fracture or pneumothorax patients undergoing elective surgery under general anesthesia entered the study. The biometric data, such as gender, age, weight, height, body mass index (BMI), and chest circumference (CC) at xiphoid level, were recorded for each patient. The anesthesia technique was the same for all patients.

After each attempt of intubation, a small disposable plastic bag (finger of disposable transparent clear non-sterile plastic glove) was attached and sealed around the tracheal tube at its proximal end (Figure 1). Then, palm pressure (i.e., light pressure with the palm of the hand equivalent to approximately 2 kg) was applied on the chest wall at the right midclavicular line on the 5th intercostal space, and plastic glove inflation was evaluated for each attempt (Figure 2). Later, capnography and auscultation confirmed proper tracheal or inadvertent esophageal intubation. Esophageal intubation was immediately diagnosed, and tracheal intubation was attempted again. Accidentally, it was observed that before applying palm pressure, plastic bag pulsation respective to cardiac pulsation was obvious among the cases that was also recorded. The collected data were analyzed using the t-test and, if needed, the Mann-Whitney U test.

Since there were no definitive data about the specificity and sensitivity of these techniques, this study considered a confidence interval of 95%, precision of 0.05, and sensitivity of 50%; consequently, the calculated number of patients needed for the study was 400. Then, considering the 70% success rate for tracheal intubation, 600 cases were considered the proper sample size for the study.

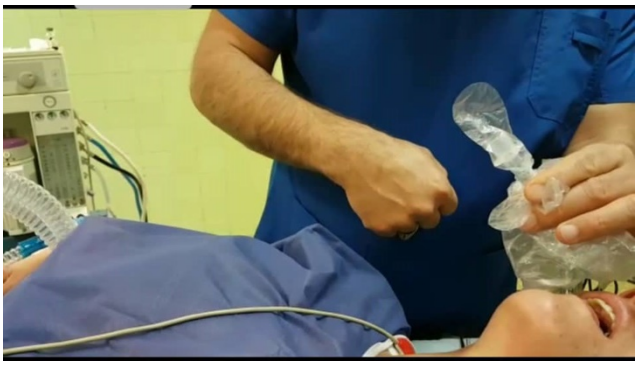

Figure 1. Finger of disposable transparent clear non sterile plastic glove has been attached and sealed around the tracheal tube at its proximal end.

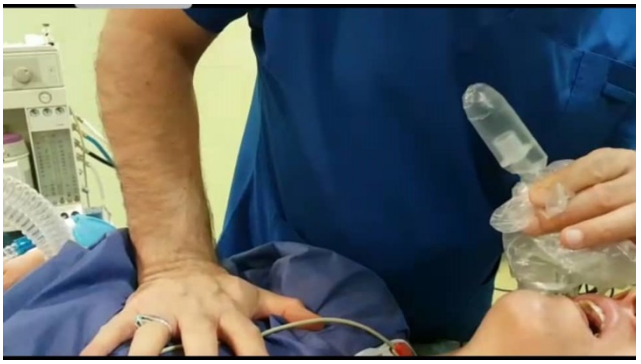

Figure 2. Palm pressure applied on chest wall at right mid clavicular line on 5th intercostal space and plastic glove inflation evaluated.

RESULTS

A total of 600 patients, including 347 females (57.8%) and 253 males (42.2%), entered the study. The subjects were within the age range of 18-70 years, with a mean value of 40.93±12.12 years. Table 1 shows other demographic data.

Table 1. Demographic data

Demographic variables	Mean ± SD
Age (year)	40.93 ± 12.12
Weight (Kg)	82.46 ± 25.23
Height (cm)	166.06 ± 17.72
BMI (Kg m^{-2})	29.66 ± 8.58
Chest circumference (cm)	94.58 ± 15.03

In 30 cases, the first attempt resulted in esophageal intubation that was changed to tracheal intubation; therefore, 630 attempts were made overall. As shown in Table 2, inflation and pulsation tests are highly sensitive and specific and have a high positive predictive value (PPV).

Table 3 shows the correlation between BMI and CC with the inability of dual tests to confirm endotracheal intubation, although the trachea was properly intubated. In some of the cases with high BMI and large CC size, where pump pressure failed to inflate, the glove had positive pulsation reaffirming the notion that the pulsation technique could give better results in such cases.

Table 2. Sensitivity, specificity and predictive values of inflation and pulsation tests

		Tracheal Intubation		Sensitivity	Specificity	PPV	NPV
		Yes (n=600)	No (N=30)				
Glove Inflation	Yes	564	0	94%	100%	100%	45.5%
	No	36	30				
Glove Pulsation	Yes	569	0	94.8%	100%	100%	49.2%
	No	31	30				

Table 3. Correlations between demographic variables, inflation and pulsation tests

	Inflation			Pulsation		
	Yes (n=564)	No (n=36)	P Value	Yes (n=569)	No (n=31)	P Value
Age (year) Mean (SD)	40.58 (12.15)	39.48 (12.36)	0.49	40.48 (12.13)	40.31 (12.60)	0.92
Height (cm) Mean (SD)	166.07 (18.04)	165.85 (10.44)	0.92	166.11 (18.04)	165.39 (9.48)	0.76
Weight (Kg) Mean (SD)	80.25 (23.49)	101.51 (29.71)	<0.001	81.06 (24.48)	95.75 (26.58)	<0.001
BMI (Kg m-2) Mean (SD)	28.83 (7.83)	36.99 (10.48)	<0.001	29.09 (8.11)	35.18 (10.09)	<0.001
Chest circumference (cm) Mean (SD)	93.11 (13.71)	107.86 (18.74)	<0.001	93.55 (14.18)	105 (18.30)	<0.001

DISCUSSION

Proper tracheal tube position could be confirmed using known techniques, such as capnography (4, 7, 8), optical devices (9, 10), EDDs (2, 3, 11), and ultrasound (1, 12-15), in operating theatre settings. Other common techniques that do not rely on particular devices, such as chest movement, auscultation, and appearance of fog in a tracheal tube (16), could not be reliable to confirm tracheal intubation. Some authorities believe that no single technique could be 100% reliable, thereby recommending the combination of two or more techniques (2, 3, 17, 18). In critical care settings, X-ray studies could also be used to confirm the tracheal tube position (19-21).

Recently, innovative and indigenous techniques have been proposed for the confirmation of tracheal intubation, such as tactile laryngeal maneuver (6) and spectral reflectance (22). Herein, the proposed technique is simple, inexpensive, and innovative and does not require expertise that shows high specificity and sensitivity and a high PPV. In comparison to Li's work, although capnography has sensitivity and specificity of 93% and 97%, respectively (18), palm pressure and inflation techniques have sensitivity and specificity of 94% and 100%, respectively. Moreover, pulsation shows a better sensitivity of 94.8% and specificity of 100%. Furthermore, capnography might not be available in all settings.

Secondary to failure reports about capnography and its misinterpretations in confirming endotracheal tube position (18), a tendency toward the use of ultrasound has been raised among clinicians. Gottlieb et al. reported ultrasound to be 98.7% sensitive and 97.1% specific for the confirmation of endotracheal intubation (23) that is more

sensitive and less specific than the dual techniques in this study. Furthermore, it is dependent on sophisticated devices and requires skill. Khan et al.'s recently new technique of tactile laryngeal maneuver had sensitivity, specificity, and PPV of 93.3%, 77.5%, and 80.6%, respectively (6) that stands far beyond the dual techniques.

Although these dual tests showed acceptable sensitivity and specificity, they were less reliable among morbidly obese patients. The highest number of false-negative reports (i.e., proper tracheal intubation but negative bag inflation after palm pressure and bag pulsation) was among morbidly obese patients with BMI and CC higher than 35 kg/m^2 and 100 cm, respectively. Future studies will better clarify the application of these findings in obese patients.

CONCLUSION

By comparing different techniques and devices, it is believed that these dual techniques provide a simple, safe, innovative, and inexpensive way to confirm endotracheal intubation.

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Conflict of interest

The authors declare no competing interests.

Clinical trial Registeration

https://www.irct.ir/trial/35302, IRCT20170109034978N2

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