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THE TRACHEAL DETECTING-BULB: A NEW DEVICE TO DISTINGUISH TRACHEAL FROM ESOPHAGEAL INTUBATION

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Abstract :

Background: The tracheal detecting-bulb (TDB) is a diagnostic tool for confirmation of tracheal intubation. Capnography is the accepted standard for such confirmation. The purpose of this investigation was to determine whether results using the TDB and capnography agree.

Methods: Four hundred patients were divided into three separate studies. In study 1, with 200 consecutive patients, tracheal intubation was performed and tested with the TDB followed by capnography. In study 2, 100 patients had the esophagus intentionally intubated, and confirmation was tested similarly. The tube was then removed and the trachea intubated, and testing followed. Study 3 involved 100 patients and used a double-blind, randomized design. The tube was intentionally inserted into either the esophagus (n = 42) or trachea (n = 58), and testing followed.

Results: In study 1, the rhythmic fill-collapse of TDB was shown in 173 patients, and always agreed with capnography; In 27 instances, the latex bulb of TDB remained collapse or only be filled, and there was no capnogram, it indicating esophageal intubation. In study 2 and 3, regardless of esophageal or tracheal intubation, agreement between TDB and capnogram was 100%. In the 400 patients studied, results from the TDB and capnogram always agreed. The sensitivity, specificity, and predictive value for the TDB in all of these studies was 100%.

Conclusions: The TDB is a valuable diagnostic technique for confirming tracheal intubation, it correctly detected esophageal and tracheal placement of the tracheal tube in all 400 patients. Results using TDB agree with results using capnography.

Key words: Tracheal intubation. Esophageal intubation. Tracheal Detecting-bulb. Capnogram.

Endotracheal intubation to secure a patient's airway is a fundamental skill in anaesthetic practice. Difficult tracheal intubation and unrecognized esophageal intubation are leading causes of anesthetic-related morbidity and mortality. The capnography is a valuable diagnostic technique for confirming tracheal intubation, but the instrument is expensive, heavy, and it can't be found everywhere, on occasion, may be artifact, because of carbon dioxide escapes from the stomach into the esophagus,[1] for this reason, it is very important that to look for an accurate, simple, cheap and easy-to-use diagnostic technique. Recently, the "tracheal detecting-bulb" (TDB) has been proposed to verify tracheal tube placement.[2]

The TDB consisted of an inflatable latex bulb fitted to the endotracheal tube (ETT, fig.1). The principal of use is the following: The trachea is held open by rigid cartilaginous rings, in addition, thorax and lung posses spring, hence, gas can free flow, In contrast, the normal esophagus is fibromuscular, with no intrinsic structure to maintain its patency, and esophagogastric lumen is absent in elasticity. if the endotracheal tube is in the trachea, when delivers a sharp compression to both side of the chest or epigastrium, intrathoracic pressure increases, gas in the lungs flows to the TDB and the latex bulb fills. When the compression is removed, intrathoracic pressure decreases, subatmospheric pressure draw the gas return to the lungs and the latex bulb collapses. The rhythmic fill-collapse of latex bulb is foundation for make a definite diagnosis.

Figure 1.

Materials and methods

Written informed consent was obtained from 400 elective surgical patients who were to have endotracheal intubation as part of their normal anesthetic management. The age of patients ranged from 7 to 89 years, with an average of 56.6 years. Their body weights ranged between 21 and 83 kg. Anesthesia was induced with propofol，fentanyl and vecuronium. After intubation, all patients received isoflurane at 1~3%. Routine monitoring including pulse oximetry, electrocardio and blood pressure monitor and capnography was used.

This investigation was divided into three phases.

Study group 1 consisted of 200 consecutive patients. After what was thought to be tracheal intubation, the cuff of ETT was inflated with 8 -10 ml of air. the TDB was connected to the ETT, and the TDB response was obtained and then the capnography (Dräger Julian).

In group 2, 100 patients were studied. After ventilation of the lungs with oxygen, the esophagus was intentionally intubated, followed by ETT cuff inflation, The position of tracheal tube was determined by the TDB and then capnography, subsequently under direct vision a second tracheal tube, identical to the first (type, length and diameter), was placed into the trachea, with the observers making the diagnosis using TDB capnography.

The third study involved 100 patients studied in a double-blind, randomized fashion. One author instructed the resident who was administering anesthesia to insert the ETT into either the esophagus (n = 42) or the trachea (n = 58) according to a random number code. Two investigators, previously out of the room, were called into the operating theater to use the TDB capnogram sequence and to determine whether results using the TDB agreed with results using capnography. If esophageal intubation had occurred, the ETT was withdrawn, the lungs were oxygenated, and the trachea was intubated, and confirmation was tested similary.

Statistical analysis comparing results using the TDB and capnography within the three groups of patients was performed. Definitions included: positive, the latex bulb remains collapsed or only was inflated; negative, the rhythmic fill-collapse of latex bulb; false-positive (FP)-latex bulb collapsed or only was inflated, tube in trachea; false-negative (FN)-the rhythmic fill-collapse of latex bulb, tube in esophagus; true-positive (TP)-latex bulb remains collapsed or only was inflated, tube in esophagus; and true-negative (TN)-the rhythmic fill-collapse of latex bulb, tube in trachea. We also calculated sensitivity [TP/(TP+FN)×100], specificity [TN/(TN+FP)×100], and positive predictive value [TP/(TP+FP)×100].

Results

In study group 1 (n = 200), the TDB and capnogram results (presence of a rectangular waveform) agreed and indicated that the tube was in the trachea in 173 patients and in the esophagus (unintentional) in 27 patients (table 1). In each of 27 instances in which the latex bulb of the TDB did not fill-collapse, there was no capnogram (flat trace). In 16 of 173 endotracheal intubations, there was a capnogram, but the TDB fill-collapse in a delayed fashion, within 3 s. This was considered a true negative. Therefore the sensitivity specificity, and positive predictive value were 100%.

In study 2, in 100 patients in whom the ETT was intentionally placed in the esophagus and then the trachea intubated, the results using the TDB and capnogram agreed in all cases (table 1). In all 100 instances, the first intubation into the esophagus was confirmed by both a failure of the latex bulb to fill-collapse and a flat capnogram. The next 100 intubations into the trachea were confirmed by 100 capnograms indicating presence of carbon dioxide, 97 immediate TDB fill-collapse, and 3 delayed TDB fill-collapse. These were true-negatives. The sensitivity, specificity, and positive predictive values within this group of 200 intubations were 100%.

Table 1.

Comparison of Tracheal Detecting-bulb and Capnography

	Study 1 (n=200)	Study 2 (n=100)	Study 3 (n=100)
Initial tracheal intubations	173	0	58
TN	157	0	56
TN delayed: 2-3 s	16	0	2
Capnogram	173	0	58
Esophageal intubations	27	100	42
FN	0	0	0
TP	27	100	42
Capnogram	0	0	0
Secondary tracheal intubations (after esophageal intubation)	27	100	42
TN	27	97	41
TN delayed: 2-3 s	0	3	1
Capnogram	27	100	42
Sensitivity(%)	100	100	100
Specificity(%)	100	100	100
Predictive value(%)	100	100	100

In study 3, 100 patients were investigated (table 1). In all instances, the observers independently knew when the trachea and the esophagus were intubated. There were no false-negatives. Sensitivity, specificity, and predictive values in this group were 100%.

Discussion

Our results suggest that the TDB is a useful diagnostic device for the anesthesiologist, and not once in esophageal intubations did the TDB fill-collapse.

We do not know why a delayed fill-collapse of the TDB occurs. Perhaps delayed fill-collapse occurs when the tube bevel is at the level of the carina or in senile patients is weak for the lungs elasticity.

The TDB does not require that the reservoir bag be squeezed, therefore, when esophageal intubation was made, it may help to avoid gastric distension and regurgitation, particularly while the patients with full stomach. The TDB makes an immediate response (2 ~ 3 s). In addition to, in the situation of cardiopulmonary resuscitation, the bilateral breath sounds and epigastric auscultation are time consuming process and usually interference cardiac compression. Therefore, this device is particularly useful during cardiopulmonary resuscitation.

References

1. Sum Ping ST, Mehta MP, Symreng T: Accuracy of the FEF CO_2 detector in assessment of endotracheal tube placement. Anesth Analg 74: 415-419,1992.

2. 童幼良. 判定气管内导管位置的快捷方法—鉴定气囊的应用. 中国麻醉与镇痛2: 131, 2000.

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