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EFFICACY OF DOUBLE-LUMEN INTUBATION PERFORMED BY PARAMEDICS ON PATIENTS WITH LUNG DAMAGE. EXPERIMENTAL, PILOT SIMULATION TRIAL

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ABSTRACT

INTRODUCTION: The airway management and the implementation of optimal oxygen therapy in trauma patients, especially unconscious ones, is a key element of prehospital management. However, in cases of trauma lung or bronchial rupture, both lungs ventilation may not be advisable. In such cases, intubation with a double-lumen endotracheal tube may be helpful, allowing to provide one-lung ventilation. The aim of the experimental study was to assess the impact of short training in intubation using double-lumen tubes on the effectiveness of intubation performance and one-lung ventilation by paramedics in a simulated trauma patient setting.

MATERIAL AND METHODS: This was a prospective, observational, randomized experimental trial. The study involved 30 paramedics. The participants had to perform tracheal intubation using Double Lumen Tube VivaSight-DL (VS-DL; ETView Ltd.; Misgav, Israel) under normal airway conditions. The effectiveness of the first intubation attempt, the time of intubation and the Cormack-Lehane scale were evaluated.

RESULTS: The effectiveness of the first attempt at intubation with a double-lumen tube was 90% and the total effectiveness of intubation was 100%. The median time of the procedure was 63 (IQR; 38–72.5) seconds.

CONCLUSIONS: In the simulation study, the paramedics were able to intubate using a double tube after a short training.

KEY WORDS: tracheal intubation; paramedic; one-lung ventilation; prehospital; medical simulation.

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INTRODUCTION

Airway management has always been one of the key elements of emergency procedures [1–3]. In many situations, including cardiopulmonary resuscitation, endotracheal intubation is recognized by such scientific societies as American Heart Association (AHA) or European Resuscitation Council (ERC) as the gold standard for airway management during resuscitation procedures [4, 5]. It allows for complete separation of the airway from the external environment, which makes it possible to perform asynchronous resuscitation, use positive end-expiratory pressure or, in extreme situations, administer drugs with the use of endotracheal route. However, there are many

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cases in which both lungs ventilation may not be recommended or even adversely affect the patient's homeostasis. An example is a situation where there has been traumatic lung injury or bronchial rupture. Tracheobronchial injuries are rare events but often life-threatening [6]. In this case, ventilation, especially with positive end-expiratory pressure, may lead to pneumothorax. Then it may be helpful to secure the airways with an intubation tube and a bronchial blocker or intubation with a double light intubation tube and to implement one-lung ventilation [7, 8].

The aim of the study was to evaluate the effectiveness of double-lumen intubation and single-lung ventilation performed by paramedics under conditions of simulated lung injury.

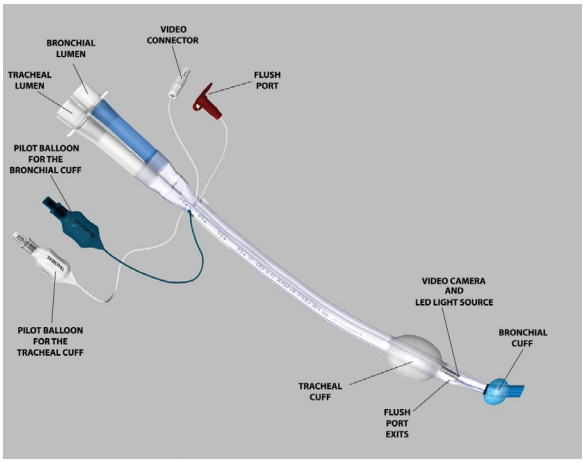

FIGURE 1. Double Lumen Tube VivaSight-DL

MATERIAL AND METHODS

The survey was an experimental study and was designed as a prospective, randomized observational study. The study protocol was approved by the Institutional Review Board of the Polish Society for Disaster Medicine (Approval no. 42.02.2019.IRB). The study was conducted with the use of medical simulation techniques. The study involved 30 paramedics, who, before starting the study, expressed a written voluntary willingness to participate in the survey.

Study design

Prior to the study, all participants attended a 60-minute training course that included both the theoretical part of tracheal intubation, intubation training with the evaluated device, and a 20-minute practical training with the Airway Management Simulator (BT Inc., Tongil-ro, Republic of Korea).

Double Lumen Tube VivaSight-DL (VS-DL; ETView Ltd.; Misgav, Israel) was used in the study. This tube is a modern double-lumen endotracheal tube. However, its advantage over standard double light tubes lies in its built-in camera, which is connected to the monitor via a fibre optic cable. The camera is positioned between the distal ends of the tube, allowing the tube to be inserted, including the observation of the distal end of the tube entering the left bronchus under visual control (Fig. 1) — without the need for the use of intubation fiberscopes.

During the target study, participants were required to perform VS-DL endotracheal intubation under normal airway conditions in a patient requiring single lung ventilation. To insert the tube between the vocal folds, the participants used a laryngoscope with a Macintosh blade (size 3; Heine Optotechnik, Munich, Germany). For this purpose, an adult SimMan 3G (Laerdal, Stavanger, Norway) simulator was used, which was placed on a standard stretcher to simulate pre-hospital conditions. The order of participants was random. During the study, only the intubator and researchers were present in the room and other participants were not allowed to stay in the room in order to reduce the risk of learning by observation.

Measurements

The primary endpoint was the rate of successful intubation. Successful intubation was defined when the one-lung of the simulator was inflated after the tracheal tube was connected to a self-inflating bag. Failed intubation was defined as an intubation time more than 120 s or when intubator gave up. The secondary endpoint were time to achieve successful DLT intubation, defined as the time when the laryngoscope passed the teeth to when the tip of the bronchial limen passed through the glottis, as confirmed visually by the operator using the video image. Moreover, we measure best view during laryngoscopy using the classification described by Cormack and Lehane [9].

Simple size calculation

The sample size was calculated with G*Power 3.1 with a two-tailed t-test (Cohen's d = 0.8, alpha error = 0.05, power = 0.95). With the minimum of 30 participants necessary.

Statistical analysis

The Statistical Package Statistica 13.3EN (Tibco Inc., Tulusa, OK, USA) was used for statistical analysis. Re-

sults obtained from each trial were compared using two-way repeated-measures analysis of variance for intubation time and Cormack-Lehane grade, and Fisher's exact test for success rate. Data are presented as median and interquartile range (IQR) or a number and mean percentage. $P < 0.05$ was considered statistically significant.

RESULTS

Participants characteristics

The study involved 30 paramedics with more than 5 years of work experience. The median age of the study participants was 30.5 (IQR; 29–35) years. None of the participants in the study had previously had any experience in intubating with a double-lumen tube, but each had experience in intubating with a standard endotracheal tube.

Intubation parameters

The effectiveness of the first attempt at intubation with a double-lumen tube was 90% and the total effectiveness of intubation was 100%. The median time of the procedure was 63 (IQR; 38–72.5) seconds. In the evaluation of the Cormack-Lehane scale, during the first phase of the insertion of a double-lumen tube between the vocal folds using a Macintosh-blade laryngoscope, 80% of the patients indicated the first degree of the Cormack-Lehane scale, while 20% of the patients indicated the second degree of the glottis visualization according to this scale.

DISCUSSION

Double-lumen intubation and one-lung ventilation are highly specialized procedures [10–12]. Due to the technique of this intubation as well as the higher costs of the equipment necessary to perform intubation compared to standard endotracheal tube, it is rarely used in pre-hospital conditions [3]. However, the development of medical technology and the development of video laryngoscopes and intubation tubes with built-in video circuits — including double-lumen tubes — may change this trend [13, 14]. There are many clinical situations in which it is reasonable to separate one lung from another and ventilate the other lung. Such clinical situations may include traumatic lung injury or bronchial rupture. Ventilation using both lungs may be ineffective and may also affect the hemodynamic parameters of the patient by inducing pneumothorax or pneumomediastinum. In such a case, the optimal solution may be double-lumen tube intubation or endotracheal intubation and the use of a bronchial blocker.

One-lung ventilation, using a double-lumen endotracheal tube or bronchial blockers is an important technique used in various clinical scenarios, but requiring more technical skills. The skills of physicians' non-experts in double-lumen endobronchial tube and bronchial blocker insertion decreases within two months without practice [15] but this procedure can be standardized and taught efficiently [16]. Several training modules and simulation training were proposed to improve knowledge and skills in bronchial blocker placement and one-lung ventilation for anaesthesiologists [17]. Some airway simulators have been proposed for lung isolation with double-lumen endotracheal tubes a bronchial blockers insertion training [18] as well as modifications to existing Airways management trainers [19].

In the author' study, the effectiveness of the first attempt of intubation with a double-lumen tube was 90% and the total effectiveness of intubation was 100%. The results are similar to other studies where videolaryngoscopes where used to facilitate endotracheal intubation [20, 21]. Bakshi et al. compared the time to intubation for double-lumen tube insertion using the McGrath® MAC VL versus direct Macintosh laryngoscope and revealed that this parameter was similar on both groups, however videolaryngoscopy was associated with better glottis visualization, reduced need of external laryngeal manipulation and fewer complications [22].

In a prospective observational study performed in 26 academic and community hospitals, Langiano et al. revealed that malposition rate for double-lumen tube was 14% and for bronchial blockers was 33% but the frequency of bronchoscope use was unexpectedly low [23]. It should be noted that intubation with the use of Double Lumen Tube VivaSight-DL does not require additional equipment, which may not be available in prehospital conditions.

In the presented study, the median time of the procedure was 63 (IQR; 38–72.5) seconds. Chang et al. compared GlideScope and lighted stylet for double-lumen endobronchial tube intubation in terms of intubation time, success rate of first attempt at intubation, difficulty in double-lumen tube advancement toward the glottis, and postoperative sore throat and hoarseness. The intubation time

for double-lumen tube was shorter in the lighted stylet group compared with the GlideScope group (30 [28–32] s vs. 45 [38–53] s). The success rate of DLT intubation in the first attempt (96.9% vs. 90.6% for lighted stylet and GlideScope, respectively) [20]. Yoo et al. compared in an open-label, randomized controlled, non-inferiority trial the time to intubation over a fiberscope using a silicone left double-lumen tube and polyvinyl chloride single lumen tube. The median time to intubation over the fiberscope was 20 s in the double-lumen group and 23 s in the single-lumen tube group [24]. El-Tahan et al. compared that laryngoscopy using the Airtraq and King Vision vs. Macintosh or GlideScope laryngoscopes in terms of intubation times for successful double-lumen endobronchial tube intubation by users with mixed experience. The channelled Airtraq resulted in shorter times for achieving successful double-lumen tube intubation (21 s) comparing to GlideScope 57.5 s [21].

There are certain limitations in the study. The first one is to perform the study in the conditions of medical simulation, not in the real conditions of prehospital intubation, however, the choice of such a method was intentional and dictated by the fact that the use of medical simulators during the teaching and evaluation of medical procedures allows for full standardization of the conditions for the performance of the procedure, as well as does not entail the risk of complications in the real patient resulting from incorrectly performed intubation, excessive duration of the procedure or repeated procedure [25, 26]. The second limitation is the fact that only paramedics are included in the study group, however, it was considered that this professional group will be the most optimal as a pilot group because paramedics relatively often meet the necessity of protecting the airway of trauma patients in pre-hospital settings [27]. The authors are currently investigating the extension of the study group to include physicians as well as other emergency scenarios, including difficult airway conditions.

Among the strengths of the study are, among others, the randomized character of the study as well as the use of one of the most modern double light tubes in the study.

CONCLUSIONS

In the simulation study, the paramedics were able to intubate using a double tube after a short training.

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