COMPARISON OF MICROASPIRATION AROUND TaperGuard TUBE CUFFS AND STANDARD TRACHEAL TUBES IN OBESE PATIENTS SUBJECTED TO SURGERY UNDER GENERAL ANESTHESIA

EWELINA GASZYŃSKA¹, PAWEŁ RATAJCZYK², ANDRZEJ WIECZOREK², TOMASZ SZEWCZYK³, TOMASZ GASZYŃSKI³

Department of Hygiene and Health Promotion, Medical University in Łódź¹
  Kierownik: prof. dr hab. F. Szatko
Chair and Department of Anesthesiology and Intensive Therapy, Medical University in Łódź²
  Kierownik: prof. dr hab. W. Gaszyński
Department of Emergency Medicine and Disaster Medicine, Medical University in Łódź³
  Kierownik: dr hab. T. Gaszyński, prof. nadzw.
Department of Gastroenterological, Oncological and General Surgery, Medical University in Łódź⁴
  p.o. Kierownika: prof. dr hab. J. Strzelczyk

Tracheal secretion leakage might lead to ventilator-associated pneumonia. Standard tracheal tube cuffs are cylindrical in shape. Bronchial tree aspiration is observed in the presence of leakage past tracheal tube cuffs. The new TaperGuard tracheal tube has a cuff in the shape of a cone, preventing from the development of microtubules and microaspiration.

The aim of the study was to compare standard tracheal tube cuffs with TaperGuard tubes, in terms of protection from microaspiration under general anesthesia.

Material and methods. The observational study evaluated incidents of leakage during general anesthesia with intubation and mechanical ventilation in patients with significant obesity. The study group comprised 20 patients with the BMI >40 kg/m² subjected to elective surgery under general anesthesia with intubation and mechanical ventilation, randomly divided into two subgroups: standard tracheal tube and TaperGuard tube.

Results. In 4 of 10 patients with standard tracheal tubes we observed leakage around the cuff. In case of TaperGuard tubes no such leakage was observed.

Conclusion. TaperGuard tubes protect against microaspirations, while standard tracheal tubes have no such properties.

Key words: endotracheal intubation, general anesthesia, tracheal tubes, cuff tightness, microaspirations, ventilator-associated pneumonia

Endotracheal intubation consists in the introduction of a tracheal tube through the nose or mouth, through the larynx and into the trachea. The decision concerning the size of the tracheal tube depends on the patients age, gender, and type of body. The cuff should ensure imperviousness between the tube and tracheal wall. Both excessive and insufficient insufflation of the tracheal tube cuff might lead to serious complications. Excessive insufflation might lead to tracheal mucous membrane ischemia, and ensuing complications. In case of insufficient insufflation the risk of aspiration increases. Asymptomatic aspiration might be responsible for Ventilator Associated Pneumonia (VAP)(1).

Tracheal tubes have different types of cuffs: low-pressure and high-volume cuff with thin and delicate walls preventing from leakage, minimalizing the development of bedsores;
high-pressure and low-volume cuff has a smaller surface of adhesion to the tracheal wall, used in case of short-term mechanical ventilation. The shape of the cuff is usually cylindrical. Covidien introduced a cone-shaped cuff. The TaperGuard tube reduces microaspiration by 90%, as compared to standard tubes (2). Fluid leakage to the trachea might be responsible for ventilator associated pneumonia (VAP). The above-mentioned infection is characterized by the occurrence of symptoms 48-72 hours since the beginning of mechanical ventilation. VAP is diagnosed in 10 to 50% of patients hospitalized at the ICU and mechanically ventilated. Mortality in case of VAP patients ranges between 30-50%. Microaspiration (tracheal leakage) was observed even in case of short-term mechanical ventilation, for example patients subjected to general anesthesia (2, 3). Most episodes of microaspiration are clinically asymptomatic, apart from transient deterioration of ventilation in the form of bronchial tree contraction and increased ventilation pressure in the airways. In some patient groups microaspiration may lead to pneumonia, complicating the postoperative period, especially in elderly patients, those prepared for immunosuppressive transplantation, as well as obese patients (4, 5).

MATERIAL AND METHODS

In the presented study we evaluated incidents of fluid leakage under general anesthesia with tracheal intubation and mechanical ventilation in significantly obese patients. The study compared standard tracheal tubes with a low-volume and high-pressure cuff, and TaperGuard tubes.

The study group comprised 20 patients with the BMI >40 kg/m² subjected to elective surgical procedures under general anesthesia with tracheal intubation and mechanical ventilation. Patients were randomly divided into two subgroups: those intubated by means of standard tracheal tubes with low-volume and high-pressure cuffs, and those with TaperGuard tubes. The tracheal tube cuffs were filled, according to the manufacturer’s recommendations by means of a manometer (fig. 1) up to a pressure of 25 cm H₂O.

At the end of the procedure we fiberoscopically evaluated whether there was fluid leakage to the trachea.

RESULTS

In 4 of 10 patients intubated by means of standard tracheal tubes fluid leakage past tracheal tube cuffs was observed (fig. 2). In case of TaperGuard tubes no such leakage was observed.

DISCUSSION

Standard tracheal tube cylindrical cuffs turned out not to protect from microaspira-
Microaspiration around TaperGuard tube cuffs and standard tracheal tubes in obese patients

The above-mentioned is illustrated by a simple experiment: the tracheal tube was placed in a transparent model of the trachea. After insufflation of the cuff with the recommended pressure (20-30 cm H₂O) we infused a blue-stained fluid imitating the secretion comprised above the cuff. After three minutes intensive fluid leakage was observed (fig. 3). After ten minutes the stained fluid was observed below the cuff.

In case of the TaperGuard tube cuff no fluid leakage was observed after 30 minutes. A small portion of the fluid leaked through the microtubules between the tracheal wall and cuff (fig. 4).

An interesting observation from the above-mentioned experiment is that there was slower leakage in case of the standard tracheal tube cuff when smaller tubes were used. This might be explained by the smaller surface of the cuff after insufflation its larger part adheres to the tracheal wall, larger microtubules do not develop, and thus, leakage is not observed.

Even properly selected cuff sizes, after insufflation, develop folds, which might lead to the development of small channels along the cuff responsible for the accumulation of secretion leaking to the bronchial tree (1). Content aspiration might lead to a series of local and systemic disturbances (2, 3). The microaspiration of the pharyngeal content, such as mucous, gastric acid, and bile with bacteria lead to the irritation of the bronchi and reflex contraction and ensuing changes, such as atelectasis. Nonsterile nasopharyngeal, gastric and duodenal secretions might accumulate and potentially contaminate the bronchial tree, which leads to lung damage or infection (6). The inflammatory reaction involves the stimulation of neutrophils, release of cytokines, as well as increased thromboxane and oxygen free radical levels. In consequence, one may observe development of infection and pneumonia. When imposed on a patients’ worse general condition, due to many coexisting diseases, or after extensive surgery, as well as in patients with impaired immunodeficiency (after transplantation), such pneumonia might possibly complicate the postoperative period, influencing worse prognosis (4, 5, 8). The cause-effect of microaspiration and pneumonia was documented (6, 7).

Due to the specific shape of the TaperGuard tube cuff one may achieve greater tightness of the intubation tubes. The cuff is cone-shaped, distally tapered. This results in the situation when the diameter of the cuff corresponds to the diameter of the trachea of a given patient, and perfectly adheres to the tracheal wall. The diameter of the cuff is equal to the diameter of the tracheal lumen, which eliminates excessive cuff material. Thus, microtubules are not formed, and microaspiration is not observed.

Based on our material and literature data the tracheal tube cuffs are not able to protect the respiratory system from microaspiration. Extremely important is the proper insufflation of tracheal tube cuffs. Our investigations demonstrated that only 28% of tracheal tube cuffs were properly insufflated, that is according to recommended pressure values (8). In the cited study the participants insufflated the tracheal tube cuffs by means of a syringe. The
tracheal tubes cuffs filled by means of a manometer increase the proportion of properly insufflated cuffs \(10\). However, even a properly insufflated cuff does not prevent from microaspirations \(11\).

**CONCLUSION**

TaperGuard tubes protect against microaspiration, while standard tracheal tubes have no such properties.

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