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Research Progress on the Use and Management of Perioperative Endotracheal Tube Cuffs

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Abstract

The use of an endotracheal tube (ETT) cuff during general anesthesia is crucial for ensuring effective ventilation, stabilizing tube position, and preventing aspiration. Recent advancements in ETT cuff research highlight the importance of standardized cuff management to reduce complications and enhance perioperative airway safety.

Keywords

Endotracheal Tube, Cuff, Pressure Monitoring, Endotracheal Intubation Complications

1. Introduction

Endotracheal intubation is a profound adjunctive ventilation measure during general anesthesia, with the endotracheal tube cuff serving to seal the airway, ensure ventilation quality, secure tube positioning, and prevent the aspiration of oral secretions or gastric contents. Cuff pressure management is a critical factor during its use, as improper management may lead to localized tracheal mucosal ischemia, hemorrhage, necrosis, and severe complications such as aspiration pneumonia and tracheoesophageal fistula [1] [2]. Furthermore, inappropriate strategies during cuff inflation or deflation may result in complications such as difficult extubation. This review aims to comprehensively summarize the current status of perioperative endotracheal tube cuff usage, management strategies, and related research advancements.

2. Basic Principles of Endotracheal Tube Cuffs

2.1. Structure and Function of the Cuff

The endotracheal tube cuff is a critical component of the tracheal intubation sys-

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tem. Its primary functions include sealing the airway to prevent gas leakage and minimizing the risk of aspiration by creating a barrier against gastric content reflux, thereby ensuring effective ventilation and oxygenation. The cuff is typically positioned at the distal end of the endotracheal tube, adhering closely to the tracheal wall to establish an airtight seal.

From an anatomical perspective, the design of the cuff must account for variations in tracheal structure and physiological characteristics. The inner diameter of the trachea exhibits significant variability among individuals, particularly in pediatric and geriatric populations. Consequently, the structural design of the cuff must accommodate diverse tracheal diameters while avoiding excessive pressure-induced mucosal injuries.

2.2. Cuff Design

In terms of design, cuffs are primarily classified into two types: high-volume low-pressure (HVLP) and low-volume high-pressure (LVHP). The HVLP cuff achieves airway sealing through a larger volume and lower pressure, thereby reducing compression on the tracheal mucosa and minimizing the incidence of complications [3]. In contrast, the LVHP cuff requires higher pressure to achieve sealing. Upon inflation, the LVHP cuff assumes a spherical shape, resulting in a smaller contact area with the tracheal wall. Consequently, the localized pressure exerted on the tracheal mucosa can reach 50 - 100 mmHg, far exceeding the capillary perfusion pressure of the tracheal mucosa (normally 25 - 35 mmHg). This significantly increases the risk of tracheal mucosal ischemia, hemorrhage, and ulceration, ultimately leading to tracheal dilation, collapse, tracheal wall necrosis, and stenosis. In some cases, tracheoesophageal fistula may also develop. Due to these adverse effects, LVHP cuffs have been phased out in clinical practice.

2.3. Inflation Mechanism of the Cuff

The inflation mechanism is critical for the proper functioning of the cuff. The inflation process is typically performed via an inflation tube connected to the cuff, through which air is introduced using a syringe. The volume of inflation directly influences cuff pressure and sealing efficacy.

In clinical practice, cuff inflation pressure must be strictly controlled. Excessive pressure may lead to tracheal mucosal ischemia and injury, whereas insufficient pressure compromises airway sealing, increasing the risk of aspiration. Therefore, the use of a manometer to measure intracuff pressure is recommended [4].

3. Cuff Usage

3.1. Cuff Inflation Management

Cuff inflation is performed to seal the gap between the tracheal tube and the tracheal wall, ensuring the tidal volume required for mechanical ventilation during general anesthesia while preventing the aspiration of respiratory secretions or gastric contents into the airway.

Currently, four primary inflation methods are commonly employed: 1) Palpation Method: A syringe is used to inflate the cuff via the pressure-indicating pilot balloon, with the anesthesiologist assessing cuff pressure based on finger palpation of the pilot balloon. The optimal pressure corresponds to a firmness similar to that of a normal human nasal tip. Although this method is the simplest in clinical practice, it heavily relies on the anesthesiologist's tactile sensitivity and experience. Studies have demonstrated that variations in cuff wall tension may influence tactile perception and judgment, and even experienced anesthesiologists cannot achieve 100% accuracy [5] [6]. 2) Minimal Occlusive Volume (MOV) Method: The cuff is inflated to the minimal pressure required to prevent air leakage. A stethoscope is placed over the trachea, and a 5 mL syringe is used to inflate the cuff until no air leak is audible. Subsequently, 0.5 mL of air is withdrawn at a time until slight leakage is detected, followed by incremental 0.5 mL reinflation until leakage ceases. This method ensures a tight seal between the cuff and tracheal wall, minimizing aspiration risk, preventing air leakage, maintaining tidal volume, and enhancing tube stability. However, the procedure is cumbersome and time-consuming, limiting its widespread clinical application. 3) Minimal Leak Technique (MLT): A stethoscope is positioned over the trachea, and the cuff is inflated until no air leak is audible. Air is then withdrawn in 0.1 mL increments until slight leakage is detected. This technique permits minor air leakage during ventilation, potentially reducing airway trauma compared to the MOV method. However, it increases aspiration risk, compromises tidal volume, and may lead to tube displacement due to reduced fixation stability. 4) Manometer Inflation Method: A dedicated manometer is connected to the cuff inflation port via a three-way connector, allowing real-time pressure monitoring during inflation. The cuff pressure is adjusted to 25 - 30 cmH_2O. This method is straightforward and provides accurate, reliable measurements. Comparative clinical studies have confirmed that this approach enables precise cuff pressure monitoring, effectively reducing mucosal injury and aspiration incidence [6].

3.2. Selection of Cuff Inflation Medium

The choice of cuff inflation medium is a critical factor influencing its performance. The most commonly used medium is air. Currently, the cuffs of clinically employed endotracheal tubes are predominantly composed of hydrophobic polyvinyl chloride (PVC). As lidocaine is a lipophilic drug, it can permeate through the cuff material and exert localized effects on the tracheal mucosa via sustained release. Based on this principle, Shroff *et al.* [7] demonstrated that intracuff injection of lidocaine effectively alleviated postoperative sore throat.

3.3. Intraoperative Influences on Cuff Pressure

The factors affecting cuff pressure can be categorized into three main aspects: patient-related factors, anesthesiologist-related factors, and perioperative factors.

- Patient-related factors: High BMI is a risk factor for abnormal cuff pressure [8]. Obesity reduces end-expiratory lung volume, leading to increased airway collapse, elevated upper airway resistance, and higher peak inspiratory pressure during mechanical ventilation. Consequently, a higher intracuff pressure is required when inserting an endotracheal tube of the same size. Similarly, smoking, asthma, and chronic bronchitis increase airway resistance and reduce dynamic lung compliance, ultimately affecting intracuff pressure [9].

- Anesthesiologist-related factors: In current clinical practice, anesthesiologists predominantly rely on the palpation method for cuff inflation, which depends on tactile feedback and experience and lacks precision. Low cuff pressure may result in air leakage, typically detectable through ventilator parameters or audible leaks. However, excessively high cuff pressure often remains clinically unrecognized. Studies have shown that when the palpation method is used, approximately one-fourth of patients exhibit cuff pressures of 20 - 30 cmH_2O, one-fourth below 20 cmH_2O, three-tenths above 30 cmH_2O, and two-tenths exceeding 40 cmH_2O [10].
- Perioperative factors: 1) Effect of positional changes: One study [11] demonstrated that when the patient's position was changed from semi-recumbent to lateral decubitus, cuff pressure increased in 82.2% of cases, while a minority exhibited decreased pressure. This finding suggests that after repositioning mechanically ventilated patients, cuff pressure should be monitored and recalibrated if necessary. Another study on orthopedic lumbar surgery found that when the patient's position was altered from supine to prone, approximately nine-tenths of patients experienced endotracheal tube displacement, with half exhibiting movement ≥10 mm. Additionally, cuff pressure changed in nearly nine-tenths of patients [12]. 2) Impact of transesophageal procedures: Insertion of a transesophageal echocardiography (TEE) probe in patients undergoing cardiac surgery has been shown to alter cuff pressure [13]. 3) Influence of anesthesia methods and surgical procedures: It has been confirmed that during anesthesia with N_2O, intracuff gas volume increases with prolonged surgical duration, leading to elevated cuff pressure, which significantly elevates the incidence of airway mucosal injury [14]. In patients undergoing anterior cervical spine surgery, the use of cervical traction devices increases both cuff pressure and peak airway pressure [15]. Geng *et al.* [16] observed that in gynecological patients undergoing laparoscopic or open abdominal surgery under general endotracheal anesthesia, cuff pressure and peak airway pressure were significantly elevated at all time points in the laparoscopic group, whereas no significant changes were noted in the open surgery group. Postoperative throat pain scores were also significantly higher in laparoscopic patients compared to open surgery patients.

3.4. Cuff Deflation Strategy

Accumulation of subglottic secretions above the endotracheal tube cuff during cuff inflation is inevitable. Aspiration of these secretions is a major cause of pulmonary infection following endotracheal intubation [17]. Residual subglottic secretions after extubation may also trigger laryngospasm, and their retention in the airway significantly increases the risk of patient asphyxiation. Therefore, prior to cuff deflation, thorough suctioning of secretions via the nasal and oral cavities must be performed. Additionally, positive pressure may be applied during cuff deflation to prevent aspiration.

The method for clearing secretions above the cuff using positive pressure is as follows:

1) Disconnect the ventilator and attach a manual resuscitation bag to the endotracheal tube.

2) Deliver several ventilations to facilitate deep inspiration by the patient.

3) Deflate the cuff while simultaneously compressing the resuscitation bag rapidly to generate positive airway pressure, propelling gas upward through the space between the cuff and the tracheal wall to expel accumulated secretions into the pharynx.

4) Immediately reinflate the cuff to prevent reflux of secretions, followed by prompt suctioning with a catheter.

Alternatively, without disconnecting the ventilator, tidal volume may be increased appropriately. The cuff is released at the onset of ventilator-delivered inspiration, utilizing the positive pressure to propel secretions from above the cuff toward the oropharynx, while concurrent suctioning is performed via the oral or nasal route [18].

4. Perioperative Cuff-Related Complications and Management

Clinical practice has demonstrated that both underinflation and excessive pressure in cuffed endotracheal tubes (ETTs) may lead to inadequate ventilation or even regurgitation and aspiration. Conversely, excessive cuff volume or pressure can result in tracheal mucosal ischemia and injury. The primary determinant of mucosal epithelial damage caused by ETT cuff compression is the ratio between cuff pressure and tracheal mucosal perfusion pressure, with the duration of compression also influencing mucosal injury. Studies [3] [19] have indicated that mucosal perfusion remains normal at a cuff pressure of 17 cmH_2O. However, when the cuff pressure exceeds 30 cmH_2O, tracheal mucosal blood flow begins to decrease. At 40 cmH_2O, mucosal blood flow is significantly reduced, manifesting as pallor, while complete cessation of mucosal perfusion occurs at 73 cmH_2O.

To minimize tracheal mucosal injury caused by endotracheal intubation, a lubricant can be applied to the surface of the tracheal tube, typically using normal saline or pharmaceutical preparations. Mekhemar *et al.* [20] demonstrated that the highest incidence of postoperative sore throat occurs at 6 hours after extubation. Local application of benzydamine hydrochloride gel on the cuff significantly reduces both the incidence and severity of postoperative sore throat compared with 5% lidocaine hydrochloride gel, 10% lidocaine hydrochloride spray, or normal saline. However, the use of 10% lidocaine hydrochloride spray increases the incidence of postoperative sore throat, though its severity does not differ significantly from that observed with 5% lidocaine gel or normal saline. This may be attributed to additives such as menthol and ethanol in the 10% lidocaine spray, which can irritate and damage the tracheal mucosa, thereby exacerbating postoperative throat pain. In contrast, Altintaş *et al.* [21] found that filling the cuff with lidocaine, rather than applying it topically, effectively reduces both the incidence and severity of post-intubation sore throat while also mitigating adverse hemodynamic changes during extubation. Lidocaine diffuses across the tracheal tube cuff in a time- and dose-dependent manner, allowing the cuff to function as a reservoir for sustained local delivery to the tracheal mucosa. However, continuous cuff pressure monitoring is essential when using this method to prevent cuff rupture, which could lead to rapid systemic absorption of lidocaine and potential toxicity. Thapa *et al.* [22] reported that lubricating the endotracheal tube with 0.05% betamethasone gel significantly reduces the incidence and severity of sore throat at 24 hours post-extubation, though it has no effect on hoarseness or cough. This benefit is primarily attributed to the long-lasting anti-inflammatory effects of betamethasone, with the lubricating properties of the gel formulation also contributing positively.

5. Emerging Technologies

5.1. Tapered-Cuff Endotracheal Tube

The tapered-cuff endotracheal tube (ETT) is a novel type of endotracheal tube recently introduced into clinical practice. The diameter and taper angle of the cuff can be adjusted according to the tracheal diameter, ensuring an effective seal for tracheas of varying shapes and sizes. This design prevents cuff folding and the formation of leakage channels, thereby effectively reducing the incidence of microaspiration [23]. The tapered-cuff suction-irrigation endotracheal tube integrates a novel tapered cuff with a separate suction-irrigation channel positioned above the cuff. This design not only ensures an effective seal between the cuff and the tracheal wall but also enables timely and efficient aspiration and irrigation of subglottic secretions, thereby further preventing microaspiration. Mahmoodpoor *et al.* [24] demonstrated that in critically ill patients requiring prolonged mechanical ventilation, the use of tapered-cuff suction-irrigation endotracheal tubes with intermittent subglottic suctioning significantly reduces the incidence of ventilator-associated pneumonia (VAP). Additionally, the researchers observed that the mean cuff pressure in the experimental group was lower than that in the control group, further highlighting the advantages of the cuff design and subglottic secretion drainage. Li *et al.* [25] found that during anterior cervical spine surgery, the use of a tapered-cuff endotracheal tube minimized the impact of surgical manipulation on cuff pressure when retracting neck tissues to expose the vertebrae, thereby reducing the incidence of postoperative intubation-related complications. Chen *et al.* [26] reported that the use of a tapered-cuff endotracheal tube reduced the incidence and severity of postoperative sore throat in patients undergoing breast surgery and improved satisfaction with anesthesia. This may be attributed to the smaller cuff–mucosa contact area of the tapered cuff. However, as the study exclusively enrolled female patients undergoing breast surgery, the findings may not be generalizable to other types of surgery.

5.2. Novel Cuff Pressure Monitoring Techniques

Management and maintenance of the endotracheal tube cuff play a critical role during the establishment of an artificial airway, which has garnered significant attention from clinicians. Consequently, numerous novel cuff pressure monitoring techniques have emerged. Farre *et al.* [27] employed a glass-chamber air pump to achieve continuous cuff pressure control. This system maintained a constant endotracheal tube cuff pressure under various influencing factors, including endotracheal tube displacement, tracheal wall tension changes, diffusion of anesthetic gases, or hypothermic surgical procedures.

6. Conclusion

In summary, the management and maintenance of endotracheal tube cuffs are of critical importance during the establishment of artificial airways and have garnered significant attention from clinicians. Novel technologies and methodologies have been developed to address clinical challenges. With further advancements in research, additional innovative techniques and approaches will be applied to endotracheal tube cuff management, thereby standardizing perioperative cuff management protocols and enhancing the safety of perioperative airway management.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Silva, M.J., Aparício, J., Mota, T., Spratley, J. and Ribeiro, A. (2008) Ischemic Subglottic Damage Following a Short-Time Intubation. *European Journal of Emergency Medicine*, **15**, 351-353. https://doi.org/10.1097/mej.0b013e3282fc9c5d

[2] Efrati, S., Deutsch, I., Antonelli, M., Hockey, P.M., Rozenblum, R. and Gurman, G.M. (2010) Ventilator-Associated Pneumonia: Current Status and Future Recommendations. *Journal of Clinical Monitoring and Computing*, **24**, 161-168. https://doi.org/10.1007/s10877-010-9228-2

[3] Seegobin, R.D. and van Hasselt, G.L. (1984) Endotracheal Cuff Pressure and Tracheal Mucosal Blood Flow: Endoscopic Study of Effects of Four Large Volume Cuffs. *BMJ*, **288**, 965-968. https://doi.org/10.1136/bmj.288.6422.965

[4] Hoffman, R.J., Parwani, V. and Hahn, I. (2006) Experienced Emergency Medicine Physicians Cannot Safely Inflate or Estimate Endotracheal Tube Cuff Pressure Using Standard Techniques. *The American Journal of Emergency Medicine*, **24**, 139-143. https://doi.org/10.1016/j.ajem.2005.07.016

[5] Pisano, A., Verniero, L., Galdieri, N. and Corcione, A. (2018) Assessing the Correct Inflation of the Endotracheal Tube Cuff: A Larger Pilot Balloon Increases the Sensitivity of the "Finger-Pressure" Technique, but It Remains Poorly Reliable in Clinical Practice. *Journal of Clinical Monitoring and Computing*, **33**, 301-305. https://doi.org/10.1007/s10877-018-0158-8

[6] Ilczak, T., Ćwiertnia, M., Białoń, P., Szlagor, M., Kudłacik, B., Rak, M., *et al.* (2021) Endotracheal Tube Cuff Pressure—Comparison of the Two Filling Methods—Simulated Test. *Prehospital and Disaster Medicine*, **36**, 421-425. https://doi.org/10.1017/s1049023x21000406

[7] Shroff, P.P. and Patil, V. (2009) Efficacy of Cuff Inflation Media to Prevent Postintubation-Related Emergence Phenomenon: Air, Saline and Alkalinized Lignocaine. *European Journal of Anaesthesiology*, **26**, 458-462. https://doi.org/10.1097/eja.0b013e32832403fa

[8] Rosero, E.B., Ozayar, E., Eslava-Schmalbach, J., Minhajuddin, A. and Joshi, G.P. (2018) Effects of Increasing Airway Pressures on the Pressure of the Endotracheal Tube Cuff during Pelvic Laparoscopic Surgery. *Anesthesia & Analgesia*, **127**, 120-125. https://doi.org/10.1213/ane.0000000000002657

[9] Weisberg, S., McCall, J. and Tennyson, J. (2017) Altitude-Related Change in Endotracheal Tube Cuff Pressures in Helicopter EMS. *Western Journal of Emergency Medicine*, **18**, 624-629. https://doi.org/10.5811/westjem.2017.3.32078

[10] Sengupta, P., Sessler, D.I., Maglinger, P., Wells, S., Vogt, A., Durrani, J., *et al.* (2004) Endotracheal Tube Cuff Pressure in Three Hospitals, and the Volume Required to Produce an Appropriate Cuff Pressure. *BMC Anesthesiology*, **4**, Article No. 8. https://doi.org/10.1186/1471-2253-4-8

[11] Godoy, A.C., Vieira, R.J. and Capitani, E.M. (2008) Endotracheal Tube Cuff Pressure Alteration after Changes in Position in Patients under Mechanical Ventilation. *Jornal brasileiro de pneumologia*: *Publicacao oficial da Sociedade Brasileira de Pneumologia e Tisilogia*, **34**, 294-297.

[12] Minonishi, T., Kinoshita, H., Hirayama, M., Kawahito, S., Azma, T., Hatakeyama, N., *et al.* (2013) The Supine-to-Prone Position Change Induces Modification of Endotracheal Tube Cuff Pressure Accompanied by Tube Displacement. *Journal of Clinical Anesthesia*, **25**, 28-31. https://doi.org/10.1016/j.jclinane.2012.05.007

[13] Tan, P., Lin, V., Chen, H. and Hung, K. (2011) The Effect of Transoesophageal Echocardiography Probe Insertion on Tracheal Cuff Pressure. *Anaesthesia*, **66**, 791-795. https://doi.org/10.1111/j.1365-2044.2011.06789.x

[14] Tu, H.N., Saidi, N., Lieutaud, T., Bensaid, S., Menival, V. and Duvaldestin, P. (1999) Nitrous Oxide Increases Endotracheal Cuff Pressure and the Incidence of Tracheal Lesions in Anesthetized Patients. *Anesthesia & Analgesia*, **89**, 187-190. https://doi.org/10.1097/00000539-199907000-00033

[15] Kako, H., Krishna, S.G., Ramesh, A.S., Merz, M.N., Elmaraghy, C., Grischkan, J., *et al.* (2013) The Relationship between Head and Neck Position and Endotracheal Tube Intracuff Pressure in the Pediatric Population. *Pediatric Anesthesia*, **24**, 316-321. https://doi.org/10.1111/pan.12308

[16] Geng, G., Hu, J. and Huang, S. (2014) The Effect of Endotracheal Tube Cuff Pressure Change during Gynecological Laparoscopic Surgery on Postoperative Sore Throat: A Control Study. *Journal of Clinical Monitoring and Computing*, **29**, 141-144. https://doi.org/10.1007/s10877-014-9578-2

[17] Rouzé, A., Jaillette, E., Poissy, J., Préau, S. and Nseir, S. (2017) Tracheal Tube Design and Ventilator-Associated Pneumonia. *Respiratory Care*, **62**, 1316-1323. https://doi.org/10.4187/respcare.05492

[18] Lapinsky, S.E., Aubin, M., Mehta, S., Boiteau, P. and Slutsky, A.S. (1999) Safety and Efficacy of a Sustained Inflation for Alveolar Recruitment in Adults with Respiratory Failure. *Intensive Care Medicine*, **25**, 1297-1301. https://doi.org/10.1007/s001340051061

[19] Payne, K.A. and Miller, D.M. (1993) The Miller Tracheal Cuff Pressure Control Valve. Clinical Use in Controlled and Spontaneous Ventilation. *Anaesthesia*, **48**, 324-327. https://doi.org/10.1111/j.1365-2044.1993.tb06954.x

[20] Mekhemar, N.A., El-agwany, A.S., Radi, W.K. and El-Hady, S.M. (2016) Comparative Study between Benzydamine Hydrochloride Gel, Lidocaine 5% Gel and Lidocaine 10% Spray on Endotracheal Tube Cuff as Regards Postoperative Sore Throat. *Brazilian Journal of Anesthesiology* (*English Edition*), **66**, 242-248. https://doi.org/10.1016/j.bjane.2014.09.007

[21] Altintas, F., Bozkurt, P., Kaya, G. and Akkan, G. (2000) Lidocaine 10% in the Endotracheal Tube Cuff: Blood Concentrations, Haemodynamic and Clinical Effects. *European Journal of Anaesthesiology*, **17**, 436-442. https://doi.org/10.1046/j.1365-2346.2000.00696.x

[22] Thapa, P., Shrestha, R.R., Shrestha, S. and Bajracharya, G.R. (2017) Betamethasone Gel Compared with Lidocaine Jelly to Reduce Tracheal Tube Related Postoperative Airway Symptoms: A Randomized Controlled Trial. *BMC Research Notes*, **10**, Article No. 361. https://doi.org/10.1186/s13104-017-2694-6

[23] D'haese, J., de Keukeleire, T., Remory, I., Van Rompaey, K., Umbrain, V. and Poelaert, J. (2013) Assessment of Intraoperative Microaspiration: Does a Modified Cuff Shape Improve Sealing? *Acta Anaesthesiologica Scandinavica*, **57**, 873-880. https://doi.org/10.1111/aas.12119

[24] Mahmoodpoor, A., Hamishehkar, H., Hamidi, M., Shadvar, K., Sanaie, S., Golzari, S.E., *et al.* (2017) A Prospective Randomized Trial of Tapered-Cuff Endotracheal Tubes with Intermittent Subglottic Suctioning in Preventing Ventilator-Associated Pneumonia in Critically Ill Patients. *Journal of Critical Care*, **38**, 152-156. https://doi.org/10.1016/j.jcrc.2016.11.007

[25] Li, Y., Tan, E.C., Tsai, Y., Mandell, M.S., Huang, S., Chiang, T., *et al.* (2022) A Tapered Cuff Tracheal Tube Decreases the Need for Cuff Pressure Adjustment after Surgical Retraction during Anterior Cervical Spine Surgery: A Randomized Controlled, Double-Blind Trial. *Frontiers in Medicine*, **9**, Article ID: 920726. https://doi.org/10.3389/fmed.2022.920726

[26] Chen, G., Lo, K., Wu, Z., Chan, S., Cheng, S., Ko, C., *et al.* (2025) Comparison of the Incidence and Severity of Postoperative Sore Throat and Subglottic Airway Injury with Cylindrical versus Tapered Cuff Endotracheal Tubes in Women Undergoing Surgery for Breast Cancer: A Randomized Controlled Trial. *BMC Anesthesiology*, **25**, Article No. 181. https://doi.org/10.1186/s12871-025-03040-y

[27] Farré, R., Rotger, M., Ferrer, M., Torres, A. and Navajas, D. (2002) Automatic Regulation of the Cuff Pressure in Endotracheally-Intubated Patients. *European Respiratory Journal*, **20**, 1010-1013. https://doi.org/10.1183/09031936.02.02692001