UDC: 616-006-089-07 DOI: 10.52532/2663-4864-2022-4-66-38-41

ENDOTRACHEAL TUBE CUFF PRESSURE CONTROL DURING ANESTHESIA IN CANCER PATIENTS

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ABSTRACT

Relevance: *An endotracheal tube (ETT) cuff provides a seal and encloses the lower airway from aspiration. Normally, the pressure in the ETT cuff is in the range of 20 to 30 cm of water column. Both increased and insufficient inflation of the ETT cuff is associated with a number of complications.*

The study aimed to *compare the palpation and apparatus methods of pressure control in the endotracheal tube cuff during anesthesia in cancer patients.*

Methods: *A prospective observational study included 60 patients during general anesthesia in the department of anesthesiology and intensive care of KazIOR. Air was injected into the ETT cuff using a syringe, followed by palpating the ETT cuff balloon and pressure control using the IntelliCuff device (Hamilton Medical, Switzerland). The actual pressure was compared with normal values, then the air volume, actual and necessary to achieve normal pressure, was estimated.*

Results: *Assessment of the pressure level by the "classic" palpation method led to errors in the pressure level in the ETT cuff in more than 50% of cases; the normal level of pressure was only in 25 patients (42%), while the measured air volume in the cuff was on average 5.9±1.9 mL, although for the average air volume to achieve a pressure of 25 mm of water column was 3.9 mL, which led to an overestimated level of pressure in the ETT cuff.*

Conclusion: *Determining ETT cuff pressure by palpating the control balloon is a common practice that often results in incorrect pressure readings. At the same time, both high and low pressure in the ETT cuff is associated with complications. Using devices for measuring pressure in the ETT cuff allows you to control its level, while devices that allow prolonged monitoring of pressure in the ETT cuff have an advantage.*

Keywords: *endotracheal tube, cuff pressure control, microaspiration, tracheal intubation, lung ventilation.*

Introduction: Since the first use of endotracheal tubes (ETT) in 1900, this technique has been the "gold standard" in maintaining airway patency [1]. Ensuring the tightness of the respiratory tract after the ETT installation provides prevention of aspiration of gastric content into the respiratory tract by inflating the intubation tubes cuff. Modern ETTs often have low-pressure cuffs, which prevent trachea wall injury. The palpation of the pilot cylinder is the standard way for ETT cuff pressure control. For a long time, it was considered that trained clinicians could determine the correct pressure in the ETT cuff, but that viewpoint had no scientific basis. Numerous clinical studies have shown that the traditional approach often leads to excessive ETT cuff pressure [2, 3]. Concerning the norm, in adult patients, the pressure level in the intubation tube cuff composes 20-30 cm of water column (on average 25 cm of water column) [4]. Exceeding this pressure level leads to deterioration of perfusion of the trachea walls, as well as the development of pain syndrome, ischemia of the trachea mucous membrane, and consequently, elevation of the risk of the complications such as the tracheal mucosa necrosis, rupture or stenosis of the trachea walls, paralysis of the laryngeal nerve and formation of the tracheoesophageal fistula [5-7]. Incorrect pressure in the ETT cuff leads to micro-aspirations and is a risk factor for ventilator-associated pneumonia [8-10]. In this regard, it is recommended to use the devices for measuring pressure in the ETT cuff. However, today there are also modern device-pressure controllers that allow not only to determine its level but also to set the target pressure values and maintain them throughout lung ventilation [11-13].

The study aimed to compare the palpation and apparatus methods of pressure control in the endotracheal tube cuff during anesthesia in cancer patients.

Materials and methods: The study was conducted in October 2022 at "Kazakh Institute of Oncology and Radiology" JSC (Almaty, Kazakhstan). Every patient or relevant legal representative gave his informed consent. A prospective observational study included 60 patients over 18 years old with malignant neoplasms (MN) of various localization who received planned surgical treatment under general anesthesia and artificial lung ventilation conditions.

Exclusion criteria: emergency surgical interventions, upper respiratory MN, childhood age, pregnancy, the physical status of the patient class III and above according to the classification of the American Society of Anesthesiologists, predicted difficult airways (3-4 points according to the Mallampati score) [14].

The study cohort profile is shown in Table 1.

Table 1 – Summary of the study cohort (n=60)

Indicator	Value
Sex	Male – 32 (53.33%) Female – 28 (46.67%)
Age	42 [36÷47]
Body Mass Index	22 [20÷23]
Basic oncological pathology	MN of the uterus and its appendages, cervix MN – 18 (30%) MN of the abdominal cavity and retroperitoneal space – 5 (8.33%) MN of eyes – 3 (5%) MN of kidneys, bladder, and prostate gland – 17 (28.33%) MN of skin and face soft tissues – 8 (13.33%) MN of the thyroid gland – 3 (5%) MN of connective and soft tissues of the lower limb, including the hip joint area – 6 (10%)
Concomitant pathology	CHD – 3 (5%) Arterial hypertension – 13 (21.67%) Diabetes mellitus types 1 and 2 – 3 (5%) Other – 11 (18.33%)
Physical status according to ASA	I – 39 (65%) II– 21 (35%)

Anesthesia in all patients was induced intravenously (with propofol 1% and fentanyl 0.005% in recommended dosages) and maintained by inhalation (with sevoflurane in combination with fentanyl). Muscle relaxation was achieved by rocuronium bromide. All patients underwent orotracheal intubation by direct laryngoscopy. The ETT cuff was inflated using a syringe. The pressure in the cuff was assessed by palpating an outer control balloon. The tightness was assessed by the absence of audible leakage of the respiratory mixture and by leakage data displayed in the anesthesia-respiratory apparatus. One hour after trachea intubation, the actual pressure in the ETT cuff was measured using the IntelliCuff device, and the result was compared with the established normal values. After determining the cuff pressure, all air was removed by a syringe, and the removed air volume was registered. The cuff was considered empty when a syringe could remove no more air. Then, the ETT cuff was connected to the IntelliCuff device, and the target value was set to 25 cm of water column. After the target pressure was achieved, the air was removed from the cuff, and its volume was measured. The nature of the main and concomitant pathologies (Table 1) did not influence the ETT cuff pressure values.

Results: The following ETT tube pressures were measured: in 25 patients (42%), ETT cuff pressure was in the range of 20-30 cm of water column; in 29 (48%), it was within the range of 31-40 cm of water column; and in 6 patients (10%), it exceeded 41 cm of water column (Figure 1).

The measured air volume in the ETT cuffs after deflating was, on average, 5.9±1.9 mL, while the required volume should average 3.9 mL. Using the IntelliCuff device allowed for avoiding wrong pressure levels and maintaining an optimal level during lung ventilation, thus preventing complications [2, 15].

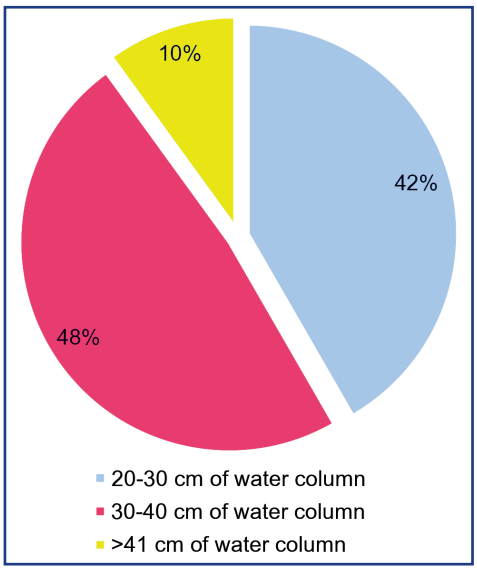

Figure 1 – Actual pressure in the ETT cuff

Discussion: Assessment of pressure in the ETT cuff by "classical" palpation can lead to incorrect – overestimated or underestimated – determination of pressure [16]. One of the studies showed that the use of the "classical" palpation method for measuring pressure in the ETT cuff led to 83% of errors, regardless of the service record of anesthesiologists [17]. However, high and low pressure in the ETT cuff is associated with worsening outcomes [15]. For example, insufficient pressure in the ETT cuff leads to microaspirations and the development of ventilator-associated pneumonia [8, 9]. In turn, a high level of pressure can lead to various complications: from pain and hoarseness to stenosis of the larynx and trachea and rupture of the trachea walls [5, 18].

The pressure control in the ETT cuff with a manometer leads to fewer complications after the tracheal intubation [7, 19]. However, modern clinical studies have shown an advantage and improvement in clinical outcomes within the frames of continuous monitoring of pressure in the ETT cuff compared with periodic measurements [20, 21].

The use of technological devices such as the IntelliCuff allows not only to control of the pressure in the ETT cuff but also to maintain it at a target level during the entire period of artificial lung ventilation, including changes in the body position and fluctuations of pressure in the respiratory tract [22].

As demonstrated in our study, using the classical palpation method to assess the pressure in the ETT cuff led to an overestimated pressure level in over half of the cases. At the same time, the pressure level in the ETT cuff was within the normative values – 20-30 cm of water column – only in 42% of patients, and in 10% of cases, an extremely high level of pressure was noted – above 41 cm of water column.

Our study had several limitations: first of all, the pressure in the ETT cuff was measured only once, one hour after tracheal intubation during the general anesthesia, and was not monitored for a longer period; secondly, the study was performed only during the general anesthesia and did not include patients on ample ventilation in the intensive care unit.

Conclusion: Determining ETT cuff pressure by palpating the control balloon is a common practice that often results in incorrect pressure readings. Both high and low pressure in the ETT cuff is associated with complications, especially in patients on prolonged ventilation. Using devices for measuring pressure in the ETT cuff allows you to control its level. However, modern technological devices, such as IntelliCuff, use a more progressive and clinically convenient approach: setting the pressure fixed by the doctor in the ETT cuff, its continuous measurement, and automatic maintenance at the proper level during the entire lung ventilation. Using these devices allows comprehensive monitoring of the pressure level in the ETT cuff and maintains it at an optimal level, reducing the risk of complications.

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АҢДАТПА

ОНКОЛОГИЯЛЫҚ НАУҚАСТАРДА АНЕСТЕЗИЯ КЕЗІНДЕ ЭНДОТРАХЕАЛЬДІ ТҮТІК МАНЖЕТІНІҢ ҚЫСЫМЫН БАҚЫЛАУ

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Өзектілігі: *Эндотрахеальды түтік (ЭТТ) екі негізгі функция орындайды: қымтаулықты қамтамасыз етеді және төменгі тыныс алу жолдарды ауыз жұтқыншақтан шыққан ластанған бөліністердің аспирациясынан қорғайды. Қалыпты жағдайда эндотрахеальды түтікше манжетасының ішіндегі қысым 20 до 30 см су бағанын құрайды. ЭТТ манжетасын шамадан тыс немесе жеткіліксіз үрлеу әр-түрлі асқынуларға әкелуі мүмкін.*

Зерттеудің мақсаты: *Онкологиялық науқастарда анестезия кезінде эндотрахеальды түтік манжетіндегі қысымды бақылаудың аппараттық әдістері мен пальпациялық әдісті салыстыру.*

Материалдар мен әдістер: *«ҚазҰҒЗИ» АҚ анестезиология, реанимация және интенсивті терапия бөлімшесінде жалпы анестезия кезіндегі проспективті бақылау 60 науқасты қамтыды. Шприцтің көмегімен ЕТТ манжетіне ауа енгізіліп, содан кейін ЕТТ манжетінің баллонын пальпациялау және IntelliCuff құрылғысы (Hamilton Medical, Швейцария) арқылы қысымды бақылау жүргізілді. Нақты қысым қалыпты мәндермен салыстырылып, содан кейін қалыпты қысымға жету үшін нақты және қажетті ауа көлемі бағаланды.*

Нәтижелері: *қысым деңгейін «классикалық» пальпациялау әдісімен бағалау 50% жоғары жағдайда қателіктерге әкелді, қалыпты қысым деңгейі тек 25 (42%) науқаста анықталды, манжетаның ішіндегі өлшенген ауа көлемі орташа 5,9±1,9мл құрады, бірақ 25 мм су бағанына сәйкес қысымға жету үшін үрленетін ауа көлемі 3,9 мл құрады, нәтижесінде ЭТТ манжетасының ішіндегі қысым деңгейі шамадан тыс болды.*

Қорытынды: Бақылау баллонын пальпациялау арқылы ЭТТ манжетінің қысымын анықтау әдеттегі тәжірибе болғанымен, жиі қысымның дұрыс емес көрсеткіштеріне әкеледі. Сонымен бірге ЭТТ манжетіндегі жоғары қысым да, төмен қысым да көптеген асқынулардың дамуына әкелуі мүмкін. ЭТТ манжетіндегі қысымды өлшеуге арналған құрылғыларды пайдалану қысым деңгейін бақылауға мүмкіндік береді, ал ЭТТ манжетіндегі қысымды ұзақ уақыт бақылауға мүмкіндік беретін құрылғылардың артықшылығы дәлелденді.

Түйінді сөздер: *эндотрахеальді түтік, манжетінің қысымын бақылау, микроаспирация, трахея интубациясы,өкпені жасанды желдету.*

АННОТАЦИЯ

КОНТРОЛЬ ДАВЛЕНИЯ В МАНЖЕТЕ ЭНДОТРАХЕАЛЬНОЙ ТРУБКИ ВО ВРЕМЯ АНЕСТЕЗИИ У ОНКОЛОГИЧЕСКИХ ПАЦИЕНТОВ

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Актуальность: *Манжета эндотрахеальной трубки (ЭТТ) обеспечивает герметичность и защищает нижние дыхательные пути от аспирации. В норме давление в манжете ЭТТ находится в диапазоне от 20 до 30 см водного столба. Как повышенный, так и недостаточный уровень раздутия манжеты ЭТТ ассоциирован с рядом осложнений.*

Цель исследования *– сравнение пальпаторного и аппаратного методов контроля давления в манжете эндотрахеальной трубки во время анестезии у онкологических пациентов.*

Методы: *В проспективное обсервационное исследование были включены 60 пациентов во время проведения общей анестезии в отделении анестезиологии, реанимации и интенсивной терапии АО «КазНИИОиР». Нагнетание воздуха в манжету ЭТТ проводили с помощью шприца, затем осуществляли пальпаторный контроль баллона манжеты ЭТТ и контроль давления при помощи устройства IntelliCuff (Hamilton Medical, Швейцария). Далее фактическое давление и объём воздуха сравнивали с нормальными показателями.*

Результаты: *Оценка уровня давления «классическим» пальпаторным методом приводила к ошибкам в уровне давления в манжете ЭТТ более чем в 50% случаев; нормальный уровень давления наблюдался только у 25 пациентов (42%). Для достижения давления в 25 мм вод. ст. средний объем воздуха составил 3,9 мл. Измеренный объем воздуха в манжете в среднем составил 5,9±1,9 мл, что приводило повышенном уровне давления в манжете ЭТТ.*

Заключение: *Определение давления в манжете ЭТТ путем пальпации контрольного баллона, хоть и является общепринятой практикой, зачастую приводит к неверному определению давления. При этом как высокое, так и низкое давление в манжете ЭТТ ассоциировано с развитием осложнений. Применение устройств для измерения давления в манжете ЭТТ позволяют контролировать его уровень, при этом преимущество имеют устройства, позволяющие проводить продленный мониторинг давления в манжете ЭТТ.*

Ключевые слова: *эндотрахеальная трубка (ЭТТ), контроль давления в манжете, микроаспирация, интубация трахеи, вентиляция легких.*

Transparency of the study: *Authors take full responsibility for the content of this manuscript.*
Conflict of Interest: *Authors declare no conflict of interest.*
Financing: *Authors declare no financing of the study.*
Authors' input: *contribution to the study concept – Abdukhalilov N.R., Arynov A.A., Baidaulet D.A., Nurmanova A.A., Seydalieva E.A.; study design – Chursin V.V., Arynov A.A.; execution of the study – Abdukhalilov N.R., Baidaulet D.A., Nurmanova A.A., Seydalieva E.A.; interpretation of the study – Abdukhalilov N.R., Arynov A.A., Baidaulet D.A., Nurmanova A.A., Seydalieva E.A.; preparation of the manuscript – Abdukhalilov N.R., Arynov A.A., Baidaulet D.A., Nurmanova A.A., Seydalieva E.A., Chursin V.V.*
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