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Research Article

Tracheotomy in Intensive Care: Techniques, Indications and Complications in a Series of 52 Cases in the Gabriel Toure University Hospital

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Abstract

The aim of our work was to identify the indications and to assess complications of tracheostomy in the intensive care setting. This work to retrospectively analyze the files of patients with tracheostomies in the multipurpose intensive care unit of the Gabriel Toure university Hospital in Bamako over 4 years from January 2016 to December 2020, including all patients with tracheostomies in intensive care or in operating room by surgical teams. The parameters taken into account were: the reasons for admission to intensive care unit, the history, the duration of intubation and ventilation before tracheostomy, the duration of total cannulation, the complications that arose during the performance of the procedure, immediately postoperatively and late. The mean age of our patients was 31.97 ± 19.03 years with extremes of 0.25 and 79 years. The sex ratio was 2.25 in favour of the male. The circumstances of hospitalization in intensive care are dominated which are neither respiratory nor neurological. The tracheotomy was performed in 52 patients, 21 patients in the operating room by an otolaryngologist including 2 in trans-isthmic and 31 times in the intensive care unit (intensive care) by an otolaryngologist team including 11 case in trans-isthmic. Tracheostomy was performed on average 2.6 ± 5.03 days after MV initiation (Median = 2 days), with extremes ranging from 0 to 45 days. Among the 52 patients included in our study, 27 patients (51.9%) underwent a tracheostomy during the first two days of MV (early tracheostomy group) and 25 patients (48.08%) underwent a tracheostomy beyond the second day of VM (Late tracheostomy group). During our study, no decanulation was carried out in the intensive care unit, the number of places reduced, does not allow hospitalized patients of which tracheostomies remain there after a slight improvement. The postoperative consequences were simple in 12 patients, or 23.1%.

Keywords

Tracheostomy, Techniques, Indications, Complications-Resuscitation

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1. Introduction

Tracheostomy is the opening of the cervical trachea followed by the placement of a cannula. It is intended to short-circuit the upper airway [1]. A tracheostomy is defined as the final connection of the trachea to the skin [2]. This emergency surgical procedure codified by Chevalier Jackson is currently a controlled procedure [1], performed in two modalities: surgical tracheostomy and percutaneous tracheostomy. Tracheostomy is one of the most common procedures performed in resuscitation patients requiring mechanical ventilation (MV) [1, 2]. Tracheostomy is often considered when the patient's pathology suggests a prolonged duration of MV or after weaning failure [3, 4]. The development of percutaneous techniques in recent years has probably contributed to the increase in the number of tracheostomies performed in the ICU. These techniques are simpler to perform, can be applied at the patient's bedside and have fewer complications [5, 6]. Compared to trans-laryngeal intubation, tracheostomy has several potential advantages [3]. It prevents laryngeal damage secondary to prolonged intubation [7], secures the tracheal approach especially in agitated patients, improves patient comfort (resumption of oral feeding and articulate speech, better mobility), and facilitates nursing care. This makes it possible to reduce or even stop sedation in patients undergoing MV and to accelerate respiratory weaning [8, 9]. In addition, tracheostomy improves the efficiency of tracheal suctioning and allows for better lung cleansing, and may therefore reduce the incidence of nosocomial pneumonia [10, 11]. Finally, tracheostomy has a beneficial effect on respiratory mechanics by reducing airway resistance and work of breathing [12, 13]. Despite all its potential benefits, tracheostomy remains subject to much controversy. The debate mainly concerns the choice of the most appropriate time to perform tracheostomy (early or late) and the impact of the latter on the outcome of resuscitation patients (weaning from MV, duration of MV and survival). This work will retrospectively analyse 52 files of tracheotomised patients managed in the resuscitation department of the Gabriel Tour éUniversity Hospital, over the last 4 years; i.e. from January 2016 to December 2020.

The aim of our work was to identify the indications and to assess complications of tracheostomy in the intensive care setting.

2. Materials and Methods

2.1. Study Design

We conducted an observational, descriptive and retrospective study from January 2016 to December 2020, including 52 patients at the Gabriel Toure University Hospital in Bamako in the department of intensive care.

2.2. Study Setting and Population

Tracheostomized patients in the intensive care unit.

2.3. Population

All patients tracheostomised in the intensive care unit by the ENT surgical teams were included. All tracheotomised patients, not performed by the ENT surgical teamsn of the Gabriel Tour éUniversity Hospital, were excluded.

2.4. Sampling

It was carried out exhaustively and covered 52 Patients.

2.5. Variables

Data were collected on a survey form using patient records and surgical registers.

The main information collected for each patient included:

1) Demographic characteristics
2) The reason for admission to the intensive care unit
3) Indications for tracheostomy
4) Timing of the tracheostomy
5) The technique used, the operator and the site where the tracheotomy is performed
6) The protocol for weaning from mechanical ventilation
7) Patient outcomes.

2.6. Data Resources

Collection Tools: We designed questionnaires that allowed us to gather the information contained in the patients' records.

Technique: We collected the records of patients who met our selection criteria.

Support for data collection: The data were recorded on a survey form designed for this purpose.

2.7. Analysis and Data Entry

Data entry was performed by Microsoft Office Word 2016, graphs by Excel 2016 and exported to SPSS (Statistical Package for Social Sciences) version 22.0 for analytical study

The statistical analysis was descriptive and presented frequencies for qualitative variables; and medians, means, standard deviations for quantitative variables.

2.8. Ethical Considerations

Respect for anonymity was taken into consideration during data collection, in accordance with the rules of medical ethics.

Finally, we conducted a literature search, and our results were compared, wherever possible, with those in the literature.

3. Results

During the study period, 52 patients were tracheostomised: 36 patients in the ICU and 16 patients in the operating theatre.

The mean age of our patients was 31.97 ± 19.03 years with

extremes of 0.25 and 79 years.

The most represented age group was 10 - 40 years.

A male predominance was revealed with 36 males against 16 females, a sex ratio of 2.25.

According to MacCabe and Jackson's classification; 35 patients or 67.3% were class 0; class 1 represented 15.4% or 8 patients and class 2 represented 17.3% or 09 patients. 69.

Tracheostomy was indicated to maintain long-term mechanical ventilation in 48 patients, 24 of whom had failed the servo or extubation test.

Four cases of emergency tracheostomy were indicated in the case of failed intubation in polycranial trauma patients with or without brain involvement.

Tracheostomy was performed on average at 2.6 ± 5.03 days in the ICU with a median of 2 days and extremes ranging from 0 to 45 days.

Early tracheostomy during the first two days was performed in 27 patients or 51.9% and late tracheostomy after the second day in 25 patients or 48.9%.

The technique used was a classic surgical technique under general anaesthesia, performed in 21 patients in the operating theatre by an otolaryngologist, 2 of whom were transisthmic, and in 31 patients in the intensive care unit by a team of otolaryngologists, 11 of whom were transisthmic. The percutaneous technique was not performed in the patients included in our study.

Low-pressure balloon cannulae were the only cannulae used during the study. The duration of cannulation varied from patient to patient depending on the pathology of admission to the intensive care unit, its evolution and the patient's respiratory status.

No decanulation was performed in the intensive care unit. The intensive care unit usually transferred patients to their appropriate departments after tracheostomy for further management.

Post-operative follow-up was simple in 12 patients (23.1%). Post-operative treatment in all cases involved antibiotic therapy, mucolytics and analgesics.

Care was provided by the ward nurses and the family or the patient himself whenever possible. Dressing changes and port care were performed on a daily basis. Humidification and tracheal suctioning with maximum asepsis using a non-traumatic flexible tube were performed several times a day.

Complications attribuTable to tracheostomy occurred in 40 patients or 76.9%.

Intraoperatively, we recorded 08 cases of haemorrhage, i.e. 20%, including one case of brachiocephalic artery injury. The distribution was 05 cases at D0 of intubation and 03 cases between D06 - D45 of intubations.

Early postoperative complications included haemorrhage in 06 cases (15%), pneumothorax in 04 cases (10%), subcutaneous emphysema in 07 cases (17.5%), accidental decanulation in 03 cases (7.5%) and tracheostomy infection in 5 patients (12.5%).

The late postoperative complications observed were purulent secretion in 5 patients (12.5%) and tracheal stenosis in 2 patients (5%), observed after an intubation-tracheostomy sequence lasting 36 days, including 45 days of intubation.

Mortality in tracheostomised patients in intensive care was 25%. These were 04 cases of head and neck trauma following a road accident, 02 cases of post-operative management of a laryngectomy, 02 cases of serious burns, 02 cases of cerebral vascular accidents and 03 cases of serious head trauma with brain involvement.

4. Discussions

Our results concerned patients hospitalised in an intensive care unit in which there was a team trained in the management of care and in the daily monitoring of tracheostomy, with an ENT technical platform adapted to tracheostomy. The frequency of tracheostomy in intensive care units varies from 5 to 30% depending on the country and the survey [2, 3, 4, 14].

An international study by Estéban et al. found an average use of tracheostomy in 13.5% of patients and a significant inter-country variability [14]. In France, this Figure is around 5% [14]. A survey by Blot et al. also showed a low value, less than 8% of ventilated patients, with a relatively long delay [3]. Both in our study and in the majority of the literature, the extreme ages were 03 months to 79 years and the mean age was 31.97 ± 19.03 years. According to Estéban [14], the most affected age group was between 17 and 82 years. In Freeman's study [15], it ranged from 32 to 76 years with a mean age of 52 ±12 years. A clear male predominance has been reported in most studies with a sex ratio ranging from 1.97 to 3.47 [15].

The reason for admission according to Ibrahim El's study was neurological in 75% of cases, represented essentially by head and neck trauma in 34.3% and cerebrovascular accidents in 12.5%. In second place, COPD in 9.4%, followed by acute respiratory distress in 6.2% and septic shock [16]. In Blot's study of 100 cases, the pathology of origin was traumatic in 36 cases, neurological in 37 cases, respiratory in 18 cases and surgical in 9 cases [3].

In the ICU, tracheostomy is rarely performed as an emergency procedure, as was the case in our study where we had to perform an emergency tracheostomy on four patients. For the majority of authors, tracheostomy should not be performed as an emergency or as a first line treatment, except in very rare cases where intubation cannot be performed beforehand. In these circumstances, tracheostomy is necessary if orotracheal intubation or cricothyroidotomy is not possible, or if there is deformity due to trauma or a large tumour of the maxillofacial sphere, larynx or hypopharynx [17]. Most often, tracheostomy is planned and performed for planned upper airway clearance and also for ventilatory support in long-term mechanical ventilation as was the case in 48 of our patients.

For urgent or scheduled release of the UAT, severe trauma of the maxillofacial sphere, bilateral vocal cord paralysis, congenital anomalies of the upper airways, post-infectious or

post-operative oedema of the oropharyngeal and laryngeal cavity are frequent [17].

Long-term ventilatory support is recommended for all severe polytrauma patients, post-cervical surgery patients, severe post-partum pre-eclampsia, or severe respiratory distress.

The advantages of tracheostomy over laryngotracheal intubation include preservation of glottic competence, a decrease in airway resistance with a reduction in work of breathing which would allow accelerated weaning from artificial ventilation, a decrease in the need for sedation and analgesia, [18, 19].

Tracheostomy does not (or only minimally) affect the functionality of the larynx or pharynx [20].

In an emergency, tracheostomy can be performed if necessary under local anaesthesia. This circumstance remains a second alternative as the simplest method of rapidly opening the upper airway remains the insertion of an endotracheal tube. If intubation is not possible, the surgical procedure of choice is cricothyrotomy. However, this technique has a high rate of long-term complications (permanent vocal cord dysfunction, subglottic stenosis) so that after 3 to 4 days, if upper obstruction persists, a conventional tracheostomy should be scheduled [21, 22].

In our study, the technique used was a classic surgical technique, performed in 21 patients in the operating room by an otolaryngologist team, including 2 transisthmusic, and 31 patients in the intensive care unit by an otolaryngologist team, including 11 transisthmusic.

It is still recommended to make the tracheal incision at least from the 2nd ring. It should preferably be horizontal between two rings with a tracheal flap over one ring, which allows easier access to the trachea in the event of accidental removal of the tracheostomy tube during the first few days following the surgical procedure [22].

The timing of tracheostomy is a hotly debated topic. It pits the proponents of late tracheostomy, performed during the third week of mechanical ventilation, against those of tracheostomy performed before the end of the first week of mechanical ventilation.

Indeed, although the most commonly accepted complications of translaryngeal intubation are damage to laryngeal structures (glottic stenosis, vocal cord laceration, vocal cord paralysis due to scarring fibrosis), these have not been shown to be correlated with the duration of intubation; they are therefore not a major argument for performing a routine tracheostomy after an arbitrary duration of intubation of, for example, two weeks, as is still the case in some centres [23]. Conversely, the complications of modern tracheostomy are much less than those reported in the 1970s and are no longer an argument for delaying the timing of tracheostomy and prolonging translaryngeal intubation [23].

Tracheostomy is usually recommended when prolonged ventilation is typically longer than 10 or 20 days [20, 24]. Tracheostomy is then proposed in order to facilitate weaning from mechanical ventilation [20].

In our study the conversion to tracheostomy was performed in 51.9% or 27 patients between 0 and 7 days. The longest delay before tracheostomy was 45 days. This is explained by several factors, including the expectation of a favourable evolution under intubation; the systematic tracheotomy on day 0 in postoperative phase of certain cervical surgeries; a lack of coordination between the ENT and intensive care units which is a source of delay in the management of the patient, the non solvency of the medical prescriptions for the realization of the act, and the persistence of a prolonged extubation-intubation by the resuscitators.

In a consensus conference of the Société de Réanimation de Langue Française, it is recommended to wait 5 to 7 days before deciding on a tracheotomy if the foreseeable duration of ventilation exceeds 15 days, in the absence of contraindications [25].

In head trauma patients, the Baltimore team showed that on the 8th day of mechanical ventilation, it was possible to predict failure of extubation and prolongation of mechanical ventilation, thus, the authors proposed that tracheotomy should be performed on the 8th day, given the low residual probability of extubation or hospital death. Finally, only one randomised prospective study, in polytrauma patients, found a benefit associated with early tracheostomy, before seven days, on the reduction of the duration of mechanical ventilation and the length of stay, but without any significant reduction in mortality [21].

In contrast, a study in burn patients found no benefit from early tracheostomy compared to tracheostomy after 14 days of intubation [26].

Complications of the tracheal approach in intensive care are still relevant, even if they are better known and prevented, and must be better screened and treated.

Surgical tracheostomy should be performed by a skilled operator in a safe surgical environment. Complications reported during this procedure, although less than 2%, are due to poor execution and require that it be performed by an experienced operator [24].

In our study, the procedure was performed by the otolaryngologist team on 21 patients in the operating room, 2 of whom were transisthenic, and 31 patients in the intensive care unit, 11 of whom were transisthenic. Post-operative follow-up was simple in 12 patients (23.1%). Complications were recorded in 40 patients (76.9%).

Several complications can occur at the time of tracheostomy or early or late postoperatively. The overall incidence of complications is approximately 15%, however, the incidence of complications with salvage tracheostomy is higher (two to five times higher) [27, 28].

Intra and early postoperative major bleeding is rare, it is more common in emergent tracheostomies. It may be the result of an error in the surgical technique. These haemorrhagic lesions most often involve the inferior thyroid veins, or the thyroid isthmus which is often divided to access the trachea. More rarely, they involve a middle thyroid artery or a higher

brachiocephalic artery trunk [28, 29].

Early postoperative bleeding is the most frequent complication in the literature with an overall incidence of between 0.8 and 5.7% [30, 31]. They are often due to insufficient haemostasis, the cough reflex.

The most serious life-threatening complication is ulceration of the brachiocephalic arterial trunk secondary to cannula-trachea-vascular axis conflict; with a mortality of approximately 75% and requiring urgent surgical intervention [32]. The complication is favoured by low tracheostomy, post-tracheostomy care, cuff hyperinflation necrosis, cannula malposition, radiotherapy [32]. It is a complication to be feared in the face of abundant tracheal bleeding or sometimes small "banal" haemorrhages that can simulate traumatic aspirations, the other suggestive sign being a pulsatility of the cannula. Early postoperative complications within the first 7 days are pneumothorax and subcutaneous emphysema, accidental decanulation, cannula obstruction and tracheostomy port infection [28, 30, 34]. Subcutaneous emphysema occurs in 5-17% of cases [36, 37], as was the case in our study with 17.5%. It is due to excessive dissection of the peri-tracheal tissues, associated with an excessively large tracheal incision and too tight a closure of the skin planes [25]. The incidence of pneumothorax after tracheostomy in adults is compromised between 0 and 5% [28, 34]. Two essential factors are responsible: high pressure ventilation, which is a source of alveolar rupture, and the significant medial depression linked to dyspnoea, which favours the penetration of air into the mediastinum during dissection of the tracheal planes [34]. In our study, pneumothorax occurred in 4 patients (10%), requiring emergency exsufflation.

Accidental decanulation depends on several factors, including the length and curvature of the cannula, the site of the tracheostomy, the surgical technique used, the method of cannula fixation and the inflation of the cuff [28, 30]. To reduce the risk of this complication, the tracheal incision should be made between the 2nd and 4th tracheal ring and the cannula should be secured in place with a collar around the neck, and it is also secured to the skin with non-absorbable thread stitches. In our study, there were 3 cases of accidental decanulation (7.5%). Obstruction of the cannula may be the result of a blood clot, mucous plug or partial mobilisation of the cannula [28]. According to David Goldenberg and P. Bradley, its incidence varies between 0.3 and 2.7% [33]. It represented 0% in our series. Tracheostomy infection remains an important and frequent complication [39]. It is favoured by repeated contamination by tracheal secretions and saliva associated with a lack of local care [28]. It was found in 5 patients in our series (12.5%). Late postoperative complications were dominated by nosocomial pneumopathy associated with purulent secretions threatening the patient's vital prognosis; also by tracheal stenosis threatening the patient's functional prognosis. These complications occurred in 7 patients in our study (17.5%). Nosocomial pneumopathies acquired in the ICU were observed in 05 patients (12.5%). The germs found in the literature are essentially represented by gram-negative bacilli and resistant staphylococci. They are associated with artificial ventilation and consequently with the translaryngeal tracheostomy tube [35]. Several controversies exist regarding diagnostic, preventive, and therapeutic aspects. [36]. Tracheostomy would reduce the incidence of pneumopathy acquired under mechanical ventilation by facilitating tracheal aspirations, maintenance of bronchial drainage in spontaneous ventilation on a tube, oral-pharyngeal and nasal hygiene, and by restoring a certain laryngeal continence [38]. With regard to stenotic and granulomatous complications, the most frequent is granuloma at the tracheostomy orifice or at the tip of the cannula [33]. Its occurrence is favoured by trauma (repeated aspirations), infection of the tracheal orifice, and a cannula unsuiTable for the trachea. The incidence of the lesion is estimated to be around 20% [33]. The granuloma is clinically manifested by local pain, haemorrhage during aspiration or when changing the cannula [33]. In our study, no cases of tracheostomy orifice granuloma were recorded. Post-tracheostomy tracheal stenosis has an incidence that varies according to the definition, i.e. the degree of reduction of the tracheal lumen, in general the threshold retained is $\geq$ 60% corresponding to the threshold having a clinical translation. The means of detection are most often endoscopic or radiographic. Its incidence can be as high as 12% in prospective studies compared to 0.5% in retrospective studies [32, 39].

The causes of tracheal stenosis are related to the patient (shock, infection, immunosuppression, malnutrition, etc.) and to technical factors (high tracheostomy above the first or second tracheal ring, cartilage resection, existence of repeated microtrauma of the cannula, lack of control of the insufflation pressure of the cannula cuff) [38, 39]. In the fin al stage of the process, cartilage lysis may occur causing tracheomalacia which may be associated with stenosis.

Currently, the use of low-pressure cuffs and the multiple daily monitoring of the effective cuff pressure has partly prevented its complications [39].

5. Conclusion

Tracheostomy is a therapeutic surgical procedure for survival and comfort. It is indicated when extubation fails or when orotracheal or nasotracheal intubation is impossible and also to maintain prolonged mechanical ventilation. The complications reported occupy a high rate of the range admitted by the literature, which is an indicator to improve the training of qualified personnel for the acquisition of better results.

Coordination of the resuscitation and ENT teams is necessary to ensure the correct timing for the clinician to convert translaryngeal intubation to a tracheostomy.

Table 1. Reason for admission to the ICU for pathologies.

Pathologies	Workforce	Percentage
Neurological	15	28,84%
Post-operative management	13	25%
Post-MVA craniofacial trauma	7	13,7%
Respiratory	7	13,7%
Severe burns	3	5,8%
Management of a cervical stab wound	2	3,8%
Post-operative management of assault and battery with a firearm	2	3,8%
Post-MVA laryngeal trauma	1	0,02%
Septic shock post MVA	1	0,02%
Management of an ingestion burn Inflammatory post-stroke	1	0,02%
Total	52	100,0%

Table 2. Complications attribuTable to tracheostomy according to time of onset.

Time to onset of complications	Complications	Number	Percentage
Per-operative	Hemorrhage	08	20%
Early post-operative	Hemorrhage	06	15%
	Pneumothorax	04	10%
	Subcutaneous emphysema	07	17,5%
	Accidental decanulation	03	7,5%
	Infection of the tracheostomy orifice	05	12,5%
	Obstruction of the cannula	0	0
	Purulent secretions	5	12,5%
Late postoperative	Tracheal stenosis	2	5%
	Granulomas	0	0

Abbreviations

COPD Chronic Obstructive Pulmonary Disease
ICU Intensive Care Unit
MV Mechanical Ventilation
UAT Upper Aerodigestive Tract

Author Contributions

Kone Fatogoma Issa: Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing

Soumaoro Siaka: Data curation, Visualization
Cisse Naouma: Writing – review & editing
Yves Christian Tchana Makasso: Formal Analysis
Dicko Ibrahim: Formal Analysis, Methodology, Writing – original draft
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Konate Oumar: Investigation
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Traore Youssouf: Investigation

Boubacary Guindo: Resources
Singare Kadidiatou: Methodology
Keita Mohamed Amadou: Validation

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Frutos-Vivar, Fernando MD; Esteban, Andrés MD, PhD; Apeztegu á, Carlos MD; Anzueto, Antonio MD; Nightingale, Peter MD; Gonz ález, Marco MD; Soto, Luis MD; Rodrigo, Carlos MD; Raad, Jean MD; David, Cide M. MD; Matamis, Dimitros MD; Empaire, Gabriel D' MD for the International Mechanical Ventilation Study Group. Outcome of mechanically ventilated patients who require a tracheostomy. Critical Care Medicine2005; 33(2): 290-298, 2005. https://doi.org/10.1097/01.CCM.0000150026.85210.13

[2] Esteban A, Anzueto A, Al á I, Gordo F, Apeztegu á C, P álizas F, Cide D, Goldwaser R, Soto L, Bugedo G, Rodrigo C, Pimentel J, Raimondi G, Tobin MJ. How is mechanical ventilation employed in the intensive care unit? An international utilization review. Am J Respir Crit Care Med. 2000 May; 161(5): 1450-8. https://doi.org/10.1164/ajrccm.161.5.9902018

[3] John E Heffner. "Tracheotomy application and timing", Clinics in Chest Medicine, 2003; 24(3): 389-398. https://doi.org/10.1016/S0272-5231(03)00044-3

[4] Benabdelouahab N, Moujtahid H, Aberouch L, Tadili J, Kettani A, et al. Tracheotomy in severe head trauma: early vs. late. J Clin Soins Intensifs M édecine 2024; 9: 001-004. https://doi.org/10.29328/journal.jcicm.1001045

[5] Massick DD, Yao S, Powell DM, Griesen D, Hobgood T, Allen JN, Schuller DE. Bedside Tracheostomy in the Intensive Care Unit: A Prospective Randomized Trial Comparing Open Surgical Tracheostomy With Endoscopically Guided Percutaneous Dilational Tracheostomy. Laryngoscope 2001; 11: 494-500. https://doi.org/10.1097/00005537-200103000-00021

[6] Delaney A, Baghsaw SM, Nalos M. Percutaneous dilatational tracheostomy versus surgical tracheostomy in critically ill patients: a systematic review and meta-analysis. Critical Care 2006; 10: 55-67. https://doi.org/10.1186/cc4887

[7] Colice GL, Stukel TA, Dain B. Laryngeal complications of prolonged intubation. Chest. 1989 Oct; 96(4): 877-84. https://doi.org/10.1378/chest.96.4.877

[8] Heffner JE. The role of tracheotomy in weaning. Chest. 2001 D; 120(6): 477S-81S. https://doi.org/10.1378/chest.120.6_suppl.477s

[9] Boynton JH, Hawkins K, Eastridge BJ, O'Keefe GE. Timing of tracheotomy and duration of weaning in patients suffering from acute respiratory failure. Critical care. August 2004; 8(4): R261-7. https://doi.org/10.1186/cc2885

[10] Kane TD, Rodriguez JL, Luchette FA. Early versus late tracheostomy in the trauma patient. Respir Care Clin N Am. 1997 Mar; 3(1): 1-20.

[11] Rumbak MJ, Newton M, Truncale T, Schwartz SW, Adams JW, Hazard PB. A prospective, randomized, study comparing early percutaneous dilational tracheotomy to prolonged translaryngeal intubation (delayed tracheotomy) in critically ill medical patients. Crit Care Med. 2004; 32(12): 2566.

[12] Wright PE, Marini JJ, Bernard GR. In vitro versus in vivo comparison of endotracheal tube airflow resistance. Am Rev Respir Dis. 1989 Jul; 140(1): 10-6. https://doi.org/10.1164/ajrccm/140.1.10

[13] Diehl JL, El Atrous S, Touchard D, Lemaire F, Brochard L. Changes in the work of breathing induced by tracheotomy in ventilator-dependent patients. Am J Respir Crit Care Med. 1999 Feb; 159(2): 383-8. https://doi.org/10.1164/ajrccm.159.2.9707046

[14] Esteban A, Anzueto A, Frutos F, Al á I, Brochard L, Stewart TE, Benito S, Epstein SK, Apeztegu á C, Nightingale P, Arroliga AC, Tobin MJ; Mechanical Ventilation International Study Group. Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study. JAMA. 2002 Jan 16; 287(3): 345-55. https://doi.org/10.1001/jama.287.3.345

[15] Freeman BD, Isabella K, Cobb JP, Boyle WA 3rd, Schmieg RE Jr, Kolleff MH, Lin N, Saak T, Thompson EC, Buchman TG. A prospective, randomized study comparing percutaneous with surgical tracheostomy in critically ill patients. Crit Care Med. 2001 May; 29(5): 926-30. https://doi.org/10.1097/00003246-200105000-00002

[16] Ibrahim El MEDDAHYA. tracheotomy in intensive care: techniques, indications and complications about a series of 32 cases; Faculty of Medicine and Pharmacy Marrakech med 2012; 117: 93-24. http://toubkal.imist.ma/handle/123456789/20113

[17] Wisocki M, Tric L, Wolff M, Gertner J, Millet H, Herman B. Noninvasive pressure support ventilation in patients with acute respiratory failure. Chest 1993; 103: 907-13. https://doi.org/10.1378/chest.103.3.907

[18] Antonelli M, Conti G, Bufi M, Costa MG, Lappa A, Rocco M, Gasparetto A, Meduri GU. Noninvasive ventilation for treatment of acute respiratory failure in patients undergoing solid organ transplantation. A randomized trial. JAMA 2000; 283: 235-41. https://doi.org/10.1001/jama.283.2.235

[19] Hilbert G, Gruson D, Vargas F, Valentino R, Gbikpi-Benissan G, Dupon M, Reiffers J, Cardinaud JP. Noninvasive ventilation in immunosuppressed patients with pulmonary infiltrates, fever, and acute respiratory failure. Nengl J Med 2001; 344: 481-7. https://doi.org/10.1056/NEJM200102153440703

[20] Terk AR, Leder SB, Burrell MI. Hyoid bone and laryngeal movement dependent upon presence of a tracheotomy tube. Dysphagia. 2007; 22(2): 89-93. https://doi.org/10.1007/s00455-006-9057-0

[21] Rodriguez JL, Steinberg SM, Luchetti FA, Gibbons KJ, Taheri PA, Flint LM. Early tracheostomy for primary airway management in the surgical critical care setting. Surgery. 1990; 108(4): 655-9.

[22] Fagon JY, Chastre J, Vuagnat A, Trouillet JL, Novara A, Gibert C. Nosocomial pneumonia and mortality among patients in intensive care units. JAMA 1996; 275: 866-9. https://doi.org/10.1001/jama.1996.03530350048033

[23] Craven DE, Barber TW, Steger KA, Montecalvo MA. Nosocomial pneumonia in the 1990s: update of epidemiology and risk factors. Semin Respir Infect. 1990; 5(3): 157-72.

[24] Heffner JE, Miller KS, Sahn SA. Tracheostomy in the intensive care unit. Part 2: Complications. Chest. 1986 Sep; 90(3): 430-6. https://doi.org/10.1378/chest.90.3.430

[25] Holzapfel L, Chevret S, Madinier G, Ohen F, Demingeon G, Coupry A, Chaudet M. Influence of long-term oro- or nasotracheal intubation on nosocomial maxillary sinusitis and pneumonia: results of a prospective, randomized, clinical trial. Crit Care Med. 1993; 21(8): 1132-8. https://doi.org/10.1097/00003246-199308000-00010

[26] Saffle JR, Morris SE, Edelman L. Early tracheostomy does not improve outcome in burn patients. J Burn Care Rehabil. 2002; 23(6): 431-8. https://doi.org/10.1097/00004630-200211000-00009

[27] El-Sayed. I. H, Bhatki. A. M and Khabie. Nissim. Complications of Tracheostomy and Tracheal Surgery. Complications in Head and Neck Surgery (Second Ed) 2009; 405-424. https://doi.org/10.1016/B978-141604220-4.50038-9

[28] Calhoun. KH et al. Management of the thyroid isthmus in tracheostomy: A prospective and retrospective study. Otolaryngol Head Neck Surg 1994; 111(4): 450-452. https://doi.org/10.1177/019459989411100410

[29] Rowshan. H, Baur. D. A. Surgical tracheotomy. Atlas oral maxillofacial Surgery Clinics Am 2010; 18: 39-50. https://doi.org/10.1016/j.cxom.2009.11.003

[30] Reilly. H, Sasaki. C. Tracheotomy complications. In Krespi YP, editor: Complications in head and neck surgery. Philadelphia, 1993, WB Saunders.

[31] Smith DK, Grillone GA, Fuleihan N. Use of postoperative chest x-ray after elective adult tracheotomy. Otolaryngol Head Neck Surg. 1999 Jun; 120(6): 848-51. https://doi.org/10.1016/S0194-5998(99)70325-6

[32] Erickson EL, Katta J, Sun S, Shan L, Lemeshow S, Schofield ML. Retrospective review of acute post-tracheostomy complications and contributing risk factors. Clinical Otolaryngology. 2024; 49(2): 277–282. https://doi.org/10.1111/coa.14131

[33] Park SY, Smith RV. Comparison of postoperative cardiopulmonary examinations and chest radiographs to detect pulmonary complications after adult tracheotomy. Otolaryngol Head Neck Surg. 1999; 121(3): 274-6. https://doi.org/10.1016/S0194-5998(99)70184-1

[34] Cipriano A, Mao ML, Hon HH, Vazquez D, Stawicki SP, Sharpe RP, Evans DC. An overview of complications associated with open and percutaneous tracheostomy procedures. Int J Crit Illn Inj Sci. 2015 Jul-Sep; 5(3): 179-88. https://doi.org/10.4103/2229-5151.164994

[35] Cardone. G, Lepe. M. Tracheostomy: Complications in Fresh Postoperative and Late Postoperative Settings. Clinical Pediatric Emergency Medicine (2010); Vol 11, Issue 2: 122-130. https://doi.org/10.1016/j.cpem.2010.04.00

[36] Mehta RM, Niederman MS. Nosocomial Pneumonia in the Intensive Care Unit: Controversies and Dilemmas. Journal of Intensive Care Medicine. 2003; 18(4): 175-188. https://doi.org/10.1177/0885066603254249

[37] Shah, G., Joshi, C., Prajapati, B. J. et al. Comparative evaluation of early versus late tracheostomy to reduce the length of stay in intensive care, the incidence of nosocomial pneumonia, the risk of laryngeal injury, and mortality in mechanically ventilated patients in a tertiary care hospital in western India. Indian J Otolaryngol Head Neck Surg 74 (Suppl 3), 5194–5198 (2022). https://doi.org/10.1007/s12070-022-03115-z

[38] Stock MC, Woodward CG, Shapiro BA, Cane RD, Lewis V, Pecaro B. Perioperative complications of elective tracheostomy in critically ill patients. Crit Care Med. 1986; 14(10): 861-3. https://doi.org/10.1097/00003246-198610000-00005

[39] Kumar AA. Endotracheal Cuff-pressure Monitoring in ICU: A Standard of Care Yet to be Standardized, and Often Neglected. Indian J Crit Care Med. 2024 Jan; 28(1): 8-10. https://doi.org/10.5005/jp-journals-10071-24624