THE CLINICAL AND SUBCLINICAL CHARACTERISTICS OF TRACHEAL STENOSIS AFTER PROLONGED ENDOTRACHEAL INTUBATION OR TRACHEOSTOMY WHICH REQUIRED TRACHEAL RECONSTRUCTIVE SURGERY

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SUMMARY

Objectives: *To survey the clinical and paraclinical characteristics of tracheal stenosis (TS) after prolonged endotracheal intubation (PEI) or tracheostomy (TO).* ***Subjects and methods:*** *A cross - sectional study on 72 patients with TS after PEI and TO required the tracheal reconstructive operation at Military Central Hospital 108 and Cho Ray Hospital.* ***Results:*** *The most common cause leading to PEI or TO is traumatic brain injury (TBI), accounting for 52.8%. The cause of TS due to PEI was higher than due to TO, with 54.2% and 45.8%, respectively. Clinically, symptoms of dyspnea were present in 52 patients (72.22%) and laryngeal stridor in 22 patients (30.55%). Flexible endoscopy could only be performed in 63 cases of which, tracheal lesions were detected in 56 cases (77.8%), combined lesions of the trachea and subglottis in 7 cases (9.7%). The level of TS according to the Myer - Cotton classification on bronchoscopy and CT scan were mainly grade III, with 54.0% and 62.5%, respectively. The average length of TS on CT scan was 15.6 ± 6.6mm (range 0.5 - 32.7mm).* ***Conclusion:*** *In the patients with TS after PEI or TO which required tracheal reconstructive surgery, the most common cause of PEI and TO was TBI (52.8%). The most common clinical symptoms were dyspnea and laryngeal stridor, and tracheal lesions and level of TS (mainly grade III according to the Myer-Cotton classification) determined by flexible endoscopy and CT scan were mainly paraclinical symptoms.*

** Keywords: Iatrogenic tracheal stenosis; Endotracheal intubation; Tracheostomy.*

INTRODUCTION

Acquired tracheal stenosis most commonly results from iatrogenic injury, such as post-intubation or/and post-tracheostomy complications [1]. Incidence of TS after PEI or TO ranges from 0.6 - 22% of patients subjected to prolonged intubation and ventilation. This type of TS remains one of the most common indications for tracheal reconstructive surgery [4].

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Presentation of post intubation or post tracheostomy TS can be varied depending on the onset and severity of the stenosis. Early, TS can present very insidious or as the onset of an asthmatic attack. In many cases, the initial condition is exposed by an acute respiratory infection as dry cough, cough with phlegm or even hemoptysis...

The mainstay of diagnostic evaluation includes cross-sectional CT scan imaging and flexible endoscopy. Treatment encompasses a variety of endoscopic intervention and open surgical techniques and should be tailored to the individual patient [3].

Therefore, the initial assessment with taking an accurate look at features of local and related trachea lesions plays an important role in designing effective treatment strategies for patients. So, our study was carried out: *To survey the clinical and paraclinical characteristics of TS after PEI or TO which required tracheal reconstructive surgery at Military Central Hospital 108 and Cho Ray Hospital.*

SUBJECTS AND METHODS

1. Subjects

Including 72 patients with a diagnosis of TS after PEI or TO which required tracheoplasty surgery at Military Central Hospital 108 and Cho Ray Hospital from January 2014 to December 2017.

** Selection criteria:*

- Patients were diagnosed TS after PEI or TO which had indications for resection and reconstruction of TS.

- Patients consented and voluntarily participated in the research.

** Exclusion criteria:*

- Tracheal stenosis due to other causes: Congenital, autoimmune, tumors of all kinds, vascular loops, thermal burns,…

- Tracheal stenosis in patients at risk of re-ventilation such as severe myasthenia gravis, progressive COPD... or other systemic diseases.

- The patient did not agree to participate in the research.

2. Methods

** Study design:*

This is a cross - sectional study. Using convenient samples according to the actual random collected records.

** General features:*

- History: Reasons leading to require endotracheal intubation or tracheostomy.

- Clinical symptoms: Cough, dyspnea, pronunciation, laryngeal stridor, fever.

- Subclinical indicators:

+ Flexible endoscopy of trachea (including flexible tracheobronchoscopy and flexible laryngoscopy): Location of stenosis, level of stenosis by Myer-Cotton classification...

+ CT scan: Location of stenosis, length of stenosis, level of stenosis by Myer - Cotton classification).

3. Statistical analysis

Data were analyzed with SPSS program 20.0. Values were presented as mean values, SD, percentage rate and p values of under 0.05 were considered as significant.

RESULTS

1. Causes of prolonged endotracheal intubation or tracheotomy

Table 1: Causes of prolonged endotracheal intubation or tracheostomy.

Causes of PEI or/and TO	Number of cases (n)	%
TBI	38	52.8
Coma by many different reasons	9	12.5
Poisoning by pesticides, sleeping drugs, chemicals…	5	6.9
Endotracheal intervention	5	6.9
Neck trauma or injury	4	5.6
Respiratory infection	3	4.2
Chest trauma	1	1.4
Others	7	9.7
Total	72	100.0

Among all 72 cases, TBI was the most common cause leading to PEI or/and TO, accounting for 52.9%. There were 39 cases (54.2%) with TS after PEI and 33 cases (45.8%) with TS after TO.

2. Clinical characteristics

There were 52 cases (72.22%) experiencing dyspnea and 22 cases (30.55%) with stridor symptoms. Besides, the number of patients who couldn't pronounce accounted for the largest proportion with 56.9% (41 cases) and the number of patients with a normal pronunciation accounted for 30.6% (22 cases) (*chart 1*).

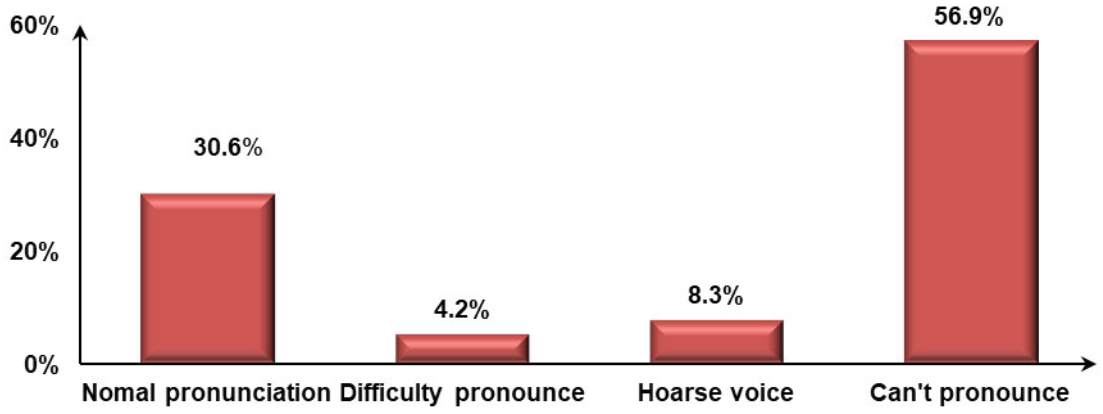

Chart 1: Distribution of patients according to pronunciation status.

Table 2: Clinical symptoms.

Clinical symptoms		Number of cases (n)	%
Cough	Without cough	10	13.9
	Dry cough	41	56.9
	Sputum cough	21	29.2
	Hemoptysis	0	00.0
Fever	Yes	2	02.8
	No	70	97.2
Stridor	Yes	22	30.6
	No	50	69.4
Total		77	100.0

The patients with dry cough accounted for 56.9%. There was not any patient with hemoptysis. Among 72 patients participating in the study, the patients without fever accounted for 97.2%.

3. Subclinical characteristics

** Characteristics of TS determined by flexible endoscopy of trachea:*

To assess tracheal lesions can use both flexible laryngoscopy and flexible bronchoscopy. Both of them were named generally flexible endoscopy of the trachea (FET).

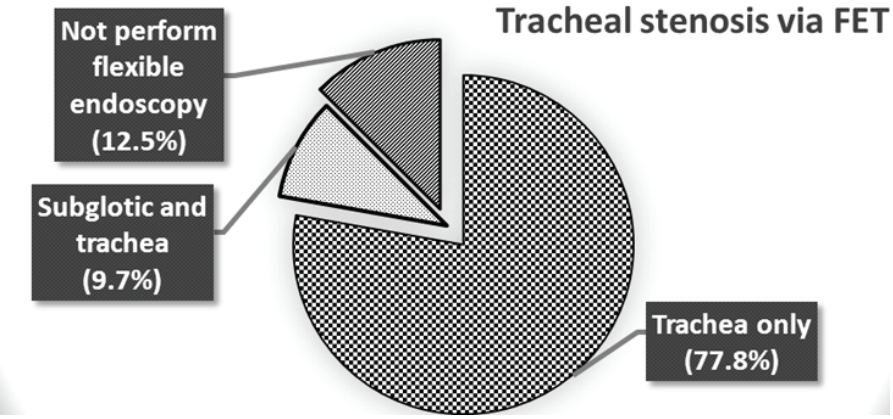

Chart 2: Tracheal stenosis via FET.

Among 72 cases, there were 63 patients (87.5%) who were performed preoperative FET. Tracheal lesions were determined in all those 63 cases in which 56 cases had tracheal lesions only (accounting for 77.8% of all patients and 88.9% of cases were performed PET) and 7 cases had combined subglottic-tracheal lesions (accounting for 9.7% of all patients and 11.1% of cases were performed PET).

Table 3: The location and level of tracheal lesions in 63 patients who performed PET.

Location and level of tracheal lesion		Number of cases (n)	(%)
Location of tracheal lesions	Upper	34	53.9
	Middle	29	46.1
	Lower	0	0.0
Level of TS according to the Myer - Cotton classification	Grade I	0	0.0
	Grade II	6	9.5
	Grade III	34	54.0
	Grade IV	23	36.5

In 63 cases performed PET, the most common location of TS was the upper segment with 34 cases (accounting for 53.9%). The most common level of TS was Grade III according to the Myer - Cotton classification with 34 cases (accounting for 46.1%).

** Characteristics of TS determined by computer tomography:*

On CT scan, the shortest stenosis segment of TS was 5.0 mm and the longest was 32.7 mm. The average length of the TS segment was 15.6 ± 6.6 mm. The most common stenosis length group was 10 - 20 mm with 36 cases (accounting for 50.0%). The least common length group was > 20 mm with 12 cases (accounting for 16.6%). The serious level of TS, according to the Myer-Cotton classification determined by CT scan was mainly grade III with 45 cases (accounting for 62.5%) (*chart 3*).

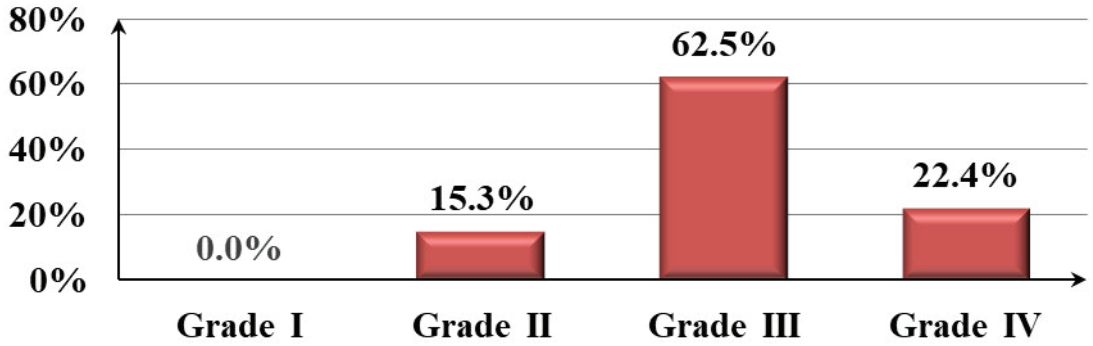

Chart 3: Myer - Cotton classification on CT scan.

DISCUSSION

1. Causes of prolonged endotracheal intubation or tracheostomy leading to tracheal stenosis

The causes leading to require PEI or TO were given in table 1. Among them, TBI was the most common cause with 38 cases (accounting for 52.9% of all patients in our study). This result was consistent with some domestic studies such as the report "Surveying the characteristics of laryngotracheal stenosis after prolonged endotracheal intubation" by Nguyen Thi My Tham et al. (2010), in which the main cause of PEI due to traumatic brain injury (TBI) was 63.2% [1]. Do Quyet et al. (2015) in his report "Studying on clinical and subclinical characteristics and initial treatment of tracheal stenosis by interventional endoscopic therapy" had also found that the main cause of tracheal stenosis was TBI, accounting for 60.1% while other causes, such as respiratory disease, cardiovascular disease, cerebral stroke, myasthenia gravis... accounted only for 7 - 16% [2]. Z Totonchi et al. showed that regardless of the reasons for hospitalization such as motor accidents, fall from height, intoxication, cardiovascular disorders, surgical procedures, pulmonary infections or cerebrovascular accident, any patients who have been intubated and have undergone mechanical ventilation for some time may increase the number of TS and its incidence varies from 0.1 to 20% [5].

In our study, there were 39 cases with TS due to PEI and 33 case with TS due to TO, accounting for 54.2% and 45.8%, respectively. Grillo et al. (2004) in a 27-year study on 503 patients undergoing TO and reconstruction due to post-intubation injury at Massachusetts General Hospital (MGH) showed that there were 251/503 (49.9%) lesions of the endotracheal balloon of PEI and 178 cases (35.4%) of stenosis at the TO site and 38 cases with both lesions [6]. In the study of Ahn HY et al (2015), there were 18 cases of TS due to PEI and TO, 10/18 (55.55%) stenosis at balloon position of PEI, 6/18 (33.33%) stenosis at the TO site and stenosis in 2 positions were 2/18(11.11%). In his study, Ahn H Y et al. (2015) identified lesions caused by 2 combined causes: intubation and endotracheal intubation [7]. In fact, it was difficult to identify these two lesions separately at the time of hospitalization, we combined time line and stenosis location to determine which is the main cause.

2. Clinical characteristics

The clinical symptoms of TS are generally insidious. Most arise 1 - 6 weeks after extubation, and early symptoms are often not recognized. The most common symptoms include shortness of breath, cough, recurrent pneumonia, wheezing, stridor, and cyanosis over time. Dyspnea is often the symptom until the tracheal diameter is 50% smaller than normal. When the tracheal diameter is 25% of its normal size, dyspnea and stridor may occur even at rest. These symptoms can be confused with other respiratory diseases [8].

In this study, 52 cases (72.22%) had a symptom of dyspnea and only 22 cases (30.55%) had stridor symptoms. Dyspnea on exertion appeared when about 50% of

the airway is narrowed. Dyspnea at rest occurs when 75% of the airway is stenosed. Typically, in adults, exertional dyspnea occurs when the airway diameter is reduced to about 8 mm; resting dyspnea occurs at a diameter of 5 mm, at which point stridor also occurs [9].

In some cases, dyspnea can be understood as shortness of breath or dyspnea is an early feeling of the patient during processing of tracheal stenosis. Dyspnea, or shortness of breath, may indicate that your body is hungry for air. It tells you that something is not working right. Shortness of breath is the most common complaint of patients with TS. Increased airway stenosis may worsen dyspnea and cause wheezing and stridor. When the airway diameter decreases to less than 8 mm, wheezing starts to occur with effort dyspnea, and when it is below 5 mm, stridor develops. In the study by Sahin, M. F et al. (2021) with 40 cases of complex TS, the most common symptom was stridor (62.5%). These authors noted that lumen diameter in the narrowest part of TS was observed to differ significantly depending on the symptoms (stridor, wheezing, dyspnea) and the lumen diameter in the narrowest part of TS in a patient with stridor was narrower than others (with $p < 0.001$). According to the lumen diameter measurement, the stridor's cut-off value in the narrowest part of the stenotic segment was calculated to be 6.5 mm [10].

Patients with pathologic lesions of the trachea usually exhibit signs and symptoms of upper airway obstruction: dyspnea on exertion, wheezing, or stridor. Unfortunately, this presentation is frequently misinterpreted as adult onset asthma. It is not uncommon for patients to undergo treatment with corticosteroids for months to years before the correct diagnosis (7.5%) was finally made. Therefore, any patient with obstructive airway and history of tracheal intubation must be considered to have airway stenosis until proven otherwise [11].

Besides, the number of patients who couldn't pronounce was 41 (accounting for the largest proportion with 56.9%). The number of patients with normal pronunciation was 22 (accounting for 30.6%) (*chart 1*). When TS has developed seriously at point force it has to require a TO to save the patient's life. This is very popular situation of TS transferred to specialized centers for tracheal surgery. The purpose of this technique is to ensure safety during transport, to solve the risk of respiratory failure. Due to tracheostomy, the patient is almost unable to speak or pronounce.

Among 72 patients participating in the study, the patients with dry cough symptoms accounted for 56.9%, the fever symptom was fewer with 6.8%, and there was no patient with hemoptysis (*Table 2*). Cough was a protective reaction of the airway as a foreign body or obstruction in the airway, especially in patients with an endotracheal cannula after tracheostomy. In this case, a respiratory infection can appear and be accompanied by symptoms of sputum cough and fever.

3. Subclinical characteristics

Bronchoscopy is one of the most valuable diagnostic approaches used to evaluate airway stenosis. However, the effectiveness of bronchoscopic approaches alone in the treatment of complex strictures is controversial. In our study, only 63 patients were performed preoperative FET and 9 patients (12.5%) were not. Tracheal lesions were only 77.8%, subglottic and tracheal combined lesions accounted for 9.7%. In fact, many patients couldn't perform flexible endoscopy of trachea because the dyspnea symptom had been developing. They were forced to a safe plan quickly as tracheostomy or an operation to resolve airway obstruction. During 27 years, Grillo (2004) had 503 patients undergone tracheal resection and reconstruction for post intubation lesions at Massachusetts General Hospital. In 441 patients, the lesions were principally tracheal. Sixty-two had involvement of the subglottic larynx as well as the upper trachea [6].

In this report, the most common TS segment was the upper segment (53.9%). The most common group was grade III according the Myer - Cotton classification by endoscopy (46.1%). When a patient has grade III of TS, it means that patients are in a dangerous condition, at high risk of experiencing all the symptoms of severe TS such as severe dyspnea, total respiratory muscle contraction, even cyanosis of respiratory failure. From our experience, patients with TS in grade III according to the Myer-Cotton classification were usually required tracheostomy for safety. Negm H. et al (2013) observed TS in 24 cases through FET: Grade II was 6 (25%), grade III was 10 (41.7%). and grade IV was 8 (33.3%). Of which, only 15 (62.5%) had cervical stenosis and 9 (37.5 %) were related to the subglottis and cricoid cartilage [12].

Among 72 patients, the level of TS according to the Myer-Cotton classification on CT scan was mainly grade III (45 cases, accounting for 62.5%) (chart 3). The shortest stenosis segment of TS on CT scan was 5.0 mm and the longest was 32.7 mm. The average length of the trachea stenosis segment on CT scan was 15.6 ± 6.6 mm. The length group 10 - 20 mm was most common (50.0%). This result was lower than other domestic and foreign studies. The reason for this different finding was that the priorities in selecting patients for our study were to ensure initially the safety and effectiveness of surgery, so that the TS lesions were not too long. Nguyen Thi My Tham et al. (2010) through CT results noted that the average length of the glottis, subglottis and trachea were 4.3 ± 1.3 mm, 19.5 ± 9 mm and 18.4 ± 7.8 mm, respectively. The narrow section length < 3 cm accounted for the majority (89.5%). The authors found a correlation between the intubation time and the development of laryngotracheal stenosis [1]. Ahn H. Y et al. (2015) in 18 cases of TS due to TO and PEI, the mean length of the stenotic segment was 2.24 cm (range: 1 to 6 cm) and the mean diameter of stenotic lesion was 5.4 mm (range: 2 to 9 mm) [7]. All authors had noted that accurate assessment of the TS length was the most important to make to prognosis of TS as well as the setup of a treatment plan.

CONCLUSION

In the patients with TS after PEI or TO, which required tracheal reconstructive operation, the most common cause of PEI and TO was TBI (52.8%). The most common clinical symptoms were dyspnea and laryngeal stridor, and tracheal lesions and level of TS (mainly grade III according to the Myer-Cotton classification) determined by flexible endoscopy and CT scan were mainly paraclinical symptoms.

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