Factors affecting occurrence of post intubation and post tracheostomy tracheal stenosis in intensive care units

Original Article

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ABSTRACT

Objective: Iatrogenic tracheal stenosis is a life threatening iatrogenic complication of prolonged endotracheal intubation and tracheostomy in intensive care units (ICUs). It is one of the toughest morbidities in otolaryngology.

Aim of the Study: This prospective observational study was conducted to detect the factors affecting occurrence of tracheal stenosis in patients subjected to tracheostomy after endotracheal intubation in ICUs.

Patients and Methods: Sixty eight patients were included in this prospective study. They were admitted to (ICUs) and were subjected to endotracheal intubation, mechanical ventilation and tracheostomy due to prolonged intubation during their stay in (ICUs). The patients were followed up after being discharged for six months to detect incidence and factors affecting occurrence of tracheal stenosis. They were followed up using flexible fiber optic tracheobronchoscopy under local anesthesia, just after weaning from mechanical ventilation three and six months later.

Results: Of the studied patients, 50 patients had no tracheal stenosis until the end of follow up period (without tracheal stenosis (WTS) group) while, 18 patients had tracheal stenosis (TS group). The mean duration of mechanical ventilation in WTS group (12.1 ± 7.6 days) was statistically shorter than that of TS groups (16.6 ± 10.4 days) (P = 0.048). Tracheostomy stoma wound sepsis was recorded in 4 patients in TS group and in 2 patients in WTS group.

Conclusion: The main predisposing factors for post intubation and post tracheostomy tracheal stenosis are tracheostomy stomal wound sepsis and prolonged duration of mechanical ventilation. In contrary, tracheal cartilage injury during tracheostomy, age, sex and reason for mechanical ventilation was found to have no role in occurrence of tracheal stenosis.

Key Words: Bronchoscopy, Intensive Care Units, Mechanical Ventilation, Tracheal Stenosis, Tracheostomy.

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INTRODUCTION

Tracheal stenosis after prolonged intubation and tracheostomy is one of the challenging problems in otolaryngology. It is an iatrogenic life threatening complication of prolonged intubation and ventilation in intensive care units (ICUs)[1]. In spite of the marked improvement of the ways of management of critically ill patients as well as modifications in designs of endotracheal and tracheostomy tubes, post intubation and tracheostomy tracheal stenosis still occurs[2]. It remains one of the most common indications for tracheal resection anastomosis[3]. Incidence of tracheal stenosis post intubation and tracheostomy ranges from 0.6 -22 % of patients subjected to prolonged intubated and ventilation[4-6]. This prospective study was conducted to investigate the factors affecting occurrence of post intubation and post tracheostomy tracheal stenosis in prolonged mechanically ventilated patients who underwent tracheostomy during their admission in ICUs.

MATERIALS AND METHODS

This prospective cohort study was conducted after obtaining approval of medical ethics committee. It was conducted to detect factors affecting occurrence of tracheal stenosis in patients subjected to prolonged intubation, ventilation and tracheostomy in ICUs. The study included patients who were intubated, mechanically ventilated and subjected to tracheostomy during the period of their admission in ICUs regardless to sex, age, and diagnosis of admission. An informed consent was obtained from the guardians of all the patients and another one was obtained from the patients themselves after improvement of their general conditions. Patients with disease or condition that may influence occurrence of tracheal stenosis, for example; patients neck , laryngeal or tracheal trauma, goiter, laryngeal tumors, benign or malignant tracheal tumors, previous tracheal surgery, autoimmune diseases (Wegener's granulomatosis, sarcoidosis) and patients who received neck radiation therapy, were excluded.

Patient's data including age, sex, diagnosis of admission, duration of endotracheal intubation before tracheostomy, duration of mechanical ventilation, tracheal cartilage injury during tracheostomy and complications of tracheostomy,

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including stomal wound sepsis, were collected during the period of their stay in ICUs. Tracheostomy was performed in all patients with open surgical techniques and was performed in the ICUs without transfer to operating theater. Timing of tracheostomy was determined by the staff members of ICUs according to daily evaluation of every patient. Patients were followed up daily during their admission in ICUs. The cuffs of endotracheal tubes and tracheostomy tubes were monitored during the duration of mechanical ventilation using cuff manometer "Posey Cufflator" ™ Endotracheal Tube Inflator and Manometer. The cuff pressure was kept below 30 cm H_2O during the whole period of mechanical ventilation.

After weaning from mechanical ventilation, patients of the study were subjected to flexible fiberoptic tracheobronchoscopy "Olympus BF type 20 D" under local anesthesia, to diagnose tracheal stenosis, whenever possible directly after weaning from mechanical ventilation. Follow up fiber optic tracheobronchoscopy was performed after three and six months from weaning of mechanical ventilation to all the patients whose first fiber optic tracheobronchoscopy was free. Once a patient was suspected to have tracheal stenosis he/she was subjected to rigid bronchoscopy to confirm diagnosis and management according to the protocol of tracheal stenosis management in our department. Site and degree of tracheal stenosis were recorded as well as the duration between termination of endotracheal intubation and diagnosis of stenosis. Cotton-Meyer grading system was used to determine the degree of stenosis[7].

According to the presence of tracheal stenosis, patients were divided into two groups; group of tracheal stenosis (TS) which included the patients who were diagnosed to have tracheal stenosis using bronchoscopy and group without tracheal stenosis (WTS) included the patients whose bronchoscopies were free of stenosis until the end of follow up period. The two groups were compared regarding the collected data to detect the factors that had a role in development of tracheal stenosis.

Statistical Analysis

Unpaired t-test was used to compare between continuous variables for normally distributed data and Mann Whitney U for non-normally distributed data. A two-tailed $P<0.05$ was considered statistically significant. All analyses were performed with the International Business Machines Statistical Package for the Social Sciences IBM SPSS 20.0 software.

RESULTS

Out of 237 patients admitted to ICUs during the period of the study only 68 patients fulfilled inclusion criteria and were included in the study. Of them, 50 patients had no tracheal stenosis until the end of follow up period (WTS group) while, 18 patients had tracheal stenosis (TS group).

Both WTS and TS groups had males more than females. The male to female distribution was 5.25:1 and 5:1 in WTS group and TS group respectively. The mean age of WTS and TS groups was 22.5 (± 15.7) and 23.5 (± 20.1) respectively. (Table 1).

Table 1: Demographic and clinical data of the studied patients

	WTS group (n=50)	TS group (n=18)	*P.value*
Age (mean±SD)	22.5 (±15.7)	23.5 (±20.1)	0.8
Sex F/M	8/42	3/15	0.7
Causes of admission			
• traumatic causes n(%)	47 (94%)	16 (88.8%)	
• other causes n(%)	3 (6%)	2 (1.1%)	

Data represented by (n) number of patients, (%) percentage, (F/M) females/ males, (WTS) without tracheal stenosis, (TS) tracheal stenosis, (mean±SD), **P.value*< 0.05 statistically significant

Most of the patients in both groups were trauma patients with multiple head, chest and limbs injuries. It represented (88.8%) of patients in TS group and (94%) of WTS group. (Table 1) Respiratory distress due to myasthenia gravis, post-partum pneumonia and post arrest due to hypoxia were the non-traumatic causes of admission in TS group while drowning and organophosphorus poisonings were the non-traumatic causes of admission in WTS group.

Tracheal stenosis was detected in 18 patients out of 68 patients of the study with incidence 26.5%. Tracheal stenosis was confirmed in all patients by rigid bronchoscopy under general anesthesia after a mean duration of (51.2±35.7) days after end of endotracheal intubation. (Figure 1) Sites of stenosis in the studied patients were summerized in (Table 2). Three patients (3/18) had stenosis of Cotton-Meyer grade one, eleven patients (11/18) had stenosis of Cotton-Meyer grade two, three patients (3/18) had stenosis of Cotton-Meyer grade three and one patient (1/18) had stenosis of Cotton-Meyer grade four.

Table 2: Comparing the two groups regarding tracheostomy technique and stomal wound infection

Sites of stenosis	Number (n)	Percentage (%)
Subglottic	5	27.8%
At level of Tracheostomy stoma	10	55.6%
Below tracheostomy stoma	2	11%
Long segment stenosis	1	5.6%

Data represented by (n) number of patients, (%) percentage

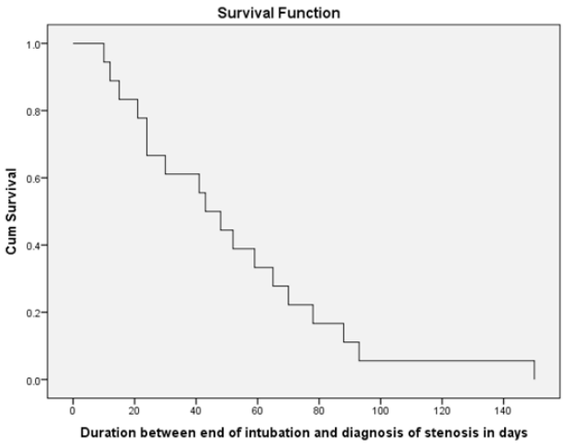

Fig1: Duration between end of intubation and diagnosis of stenosis in days.

The duration of intubation of the WTS group (8.8 ± 5.8 days) was shorter than that of TS group (9.3 ± 4.4 days) but without statistical significance (*P*=0.74) (Table 3). Notably, no tracheal stenosis was detected in patients who were intubated for duration less than 6 days.

Table 3: Comparing the two groups regarding data of intubation and mechanical ventilation

	WTS (n=50)	TS (n=18)	*P.value*
Duration of intubation in days (mean±SD)	8.8 (±5.8)	9.3 (±4.4)	0.72
Duration of mechanical ventilation in days* (mean±SD)	12.1 (±7.6)	16.6 (±10.4)	0.048*

Data represented by (n) number of patients, (%) percentage, (WTS) group without tracheal stenosis, (TS) tracheal stenosis, (mean±SD), **P.value*< 0.05 statistically significant

There was no correlation between the duration of intubation and degree of tracheal stenosis; the average duration of intubation of patients with Cotton-Meyer grade one stenosis was nine days, while that of patients with Cotton-Meyer grade two was seven days. On the other had those had Cotton-Meyer grade three stenosis were intubated for 13 days and those had Cotton-Meyer grade four stenosis were intubated for five days.

The mean duration of mechanical ventilation in WTS group (12.1 ± 7.6) was statistically shorter than that of TS groups (16.6 ± 10.4) days (*P* = 0.048, Table 3) The mean duration of mechanical ventilation through endotracheal tube was 8.8 (± 5.8) days and 9.2 (± 4.4) days for TS group and WTS group respectively. The mean duration of mechanical ventilation through tracheostomy tube was (5.9 ± 5.4) days and (9.1 ± 6.5) days for TS group and WTS group respectively.

Tracheal stoma wound sepsis was recorded in six patients (8.8 %) while tracheoesophageal fistula was documented in one patient, secondary heamorrahge was recorded in one patient (1.4 %), insertion of tracheostomy in false passage in one patient (1.4 %), and cardiac arrest in one patient (1.4 %).

Tracheostomy stoma wound sepsis was recorded in 4 patients in TS group and in 2 patients in WTS group. There was a statistically significant association between tracheostomy stomal wound infection and occurrence of tracheal stenosis (*P* = 0.02). (Table 4)

Table 4: comparing the two groups regarding tracheostomy technique and stomal wound infection

	WTS (n=50)	TS (n=18)	*P.value*
Tracheostomy stomal wound infection* n (%)	2 (4%)	4 (22.2%)	0.02*
Tracheal cartilage injury during tracheostomy n(%)	20(40%)	9 (50%)	0.46

Data represented by (n) number of patients, (%) percentage, (WTS) group without tracheal stenosis, (TS) tracheal stenosis, (mean±SD), **P.value*< 0.05 statistically significant.

There was no statistically significant difference between the two groups regarding age, sex, diagnosis of admission and cartilage injury during tracheostomy. (Table 1)

DISCUSSION

Many publications discussed the etiology of post intubation and/or tracheostomy tracheal stenosis.1-6 Usual factors responsible for tracheal stenosis are: cuff pressure, size of the tube relative to tracheal lumen, duration of intubation and movement of the tube during the period of intubation.7 Tracheal stenosis was attributed to mechanical damage to the tracheal mucosa, compression and ischemia which leads to necrosis.8 While others explained tracheal stenosis by increase cuff pressure more than the mucosal capillary pressure (30 mm Hg) of the trachea, thus the mucosa that lies between the cuff and the underlying cartilages develops ischemia, long standing ischemia can lead to ulceration and chondritis of tracheal cartilages followed by fibrotic healing, leading to progressive tracheal stenosis 4 Some authors attributed tracheal stenosis to tracheostomy stomal wound sepsis, aspiration of gastric juice, corticosteroids administration and low blood pressure during period of intubation[6, 9, 10].

In the current study, tracheostomy stomal wound infection was associated with occurrence of tracheal stenosis. This was in consentience with Stauffer et al. (1981) as well as Sarpar *et al.* (2015), who stated that tracheostomy stomal infection lead to delayed healing of the stoma and it was the cause of tracheal stenosis in 42 % of their cases[4, 8]. Squire *et al.* (1990) studied the role of infection in acquired tracheal stenosis and stated the same results[9]. More attention should be given to tracheostomy stoma care to decrease the incidence of tracheostomy stomal wound infection and thus the tracheal stenosis.

Also in this study, prolonged duration of mechanical ventilation was found to be associated with tracheal

stenosis. This was identical to Badr El Din *et al.* (2014) who attributed tracheal stenosis to prolonged mechanical ventilation. This can be explained by prolonged mechanical injury to the tracheal mucosa, the effect of cuff pressure, either of endotracheal or tracheostomy tubes, on the tracheal wall as well as the unsupported weight of connectors of mechanical ventilators[10].

Thought, the duration of intubation of the TS group was longer than that of WTS group and tracheal stenosis was not detected in patients who were intubated for less than 6 days, the duration of intubation was found not to have significant association with tracheal stenosis. These results were the same as that of Stauffer *et al.* (1981) but in contrary to Lee *et al.* (2015)[4, 11].

The mean duration between weaning from mechanical ventilation and diagnosis of tracheal stenosis was 51 days, this was in coherence to Wain *et al.* (2003) who stated that the ischemic injury begins within the first few hours of intubation and healing of the damaged region can result in fibrosis within 21 to 50 days[3].

In the current study, tracheal cartilage injury during open surgical tracheostomy was found not to be predisposing factor for post tracheostomy tracheal stenosis. This was in contrary to Jung kwon *et al.* (2003) who studied experimental tracheal stenosis after tracheal cartilage injury in animals[12].

In this study, the incidence of tracheal stenosis (26.5 %) was relatively higher than that reported in the literature[13,14]. More attention should be given in our ICUs to detect the causes of tracheal stenosis and trials should be done to decrease this high incidence of stenosis. In the literature, incidence of tracheal stenosis Post percutaneous dilatation tracheostomy was higher than open surgical technique[6].

CONCLUSION

The main predisposing factors for post intubation and post tracheostomy tracheal stenosis are tracheostomal wound sepsis and prolonged duration of mechanical ventilation. In contrary, tracheal cartilage injury during tracheostomy, age, sex and the cause of mechanical ventilation was found to have no role in occurrence of tracheal stenosis. There was no relation between the duration of intubation and the degree of tracheal stenosis.

CONFLICT OF INTEREST

There are no Conflict of Interest.

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