

Surgical Outcomes of Post Intubation Tracheal Stenosis (Endotracheal Tube and/or Tracheostomy Tube)

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Abstract

Background: Tracheal intubation for long time can lead to tracheal stenosis at different levels from the tip of endotracheal tube up to the subglottic and glottis area. The most common sites are the cuff of endotracheal tube and the stoma after tracheostomy. We have variable choices for the treatment including laser, endoscopic dilatation, tracheal stents, and tracheal resection.

Patients and Methods: this is a prospective study of 40 patients who had tracheal stenosis after prolonged intubation. We admitted them to the thoracic surgery unit in Kasr Alainy Hospital, Cairo University from the period between October 2018 and October 2019 and were managed by bronchoscopic dilatation initially followed by primary tracheal resection and re-anastomosis.

Results: Tracheal resection and re-anastomosis was successful in 38 patients (95%) with excellent results and no post-operative symptoms. Regarding complications in the study only two patients developed recurrent tracheal stenosis following primary resection and re-anastomosis who needed permanent tracheostomy. One mortality case due to cardiac cause.

Conclusion: Tracheal resection and re-anastomosis is an excellent definitive management regarding complete symptomatic resolution, total hospital stay and interventional complication. Regarding the timing of application, success in early stages of disease onset without the need for prolonged conservative management is more superior to its delayed application to avoid disease progression

Keywords: Benign tracheal stenosis, Post-intubation stenosis, Tracheostomy, Tracheal resection and re-anastomosis, Bronchoscopic dilatation.

Introduction

Tracheal intubation for long time can lead to tracheal stenosis at different levels from the tip of endotracheal tube up to the subglottic and glottis area. The most common sites are the cuff of endotracheal tube and the stoma after tracheostomy (Poetker et al, 2006).

Tracheal stenosis after tracheostomy is due to excess granulation tissue formation at the stoma site (Ricketti et al. 2010). The main aetiology is the loss of local blood supply due to cuff pressure (Wain, 2003).

We do tracheal dilatation by using the rigid bronchoscopy as a temporary maneuver before the definitive surgery as emergent treatment of tracheal strictures (Simpson et al., 1982). Recurrence of the stenosis may redevelop within days to weeks. Tracheal stents are indicated for the patients who are not good surgical candidates. Tracheostomy is an acceptable option for the management of tracheal stenosis in patients who have high surgical risks for the intervention. (Peskind et al., 1993).

Patients and Methods

This study is an observational prospective study aimed to determine the indications, timing, early outcome and complications of the surgical management of tracheal stenosis presenting in patients with post intubation tracheal stenosis (endotracheal and/or tracheostomy tube). The study was conducted at the Department of Cardiothoracic Surgery in Kasr Alainy Hospital, Cairo University in the period between October 2018 and October 2019.

The study included 40 patients presenting with post intubation tracheal stenosis with 15 patients presenting with tracheal stenosis after tracheostomy tube and 25 patients after endotracheal tube, with symptomatic tracheal stenosis above, below or at the level of the stoma in the form of Dyspnea Grades 1- 4 or stridor.

After approval of the local ethical committee and obtaining an informed consent from each patient. The study included patients presenting with symptomatic post intubation tracheal stenosis. We excluded patients with neoplastic causes, irreversible etiology for intubation, tracheomalacia, tracheo-esophageal fistula and laryngeal, cricoid tracheal stenosis.

Preoperative preparation.

All patients were subjected before any intervention to detailed history taken as regard age, sex, occupation, BMI, special habits of medical importance, cause of prolonged intubation whether medical or traumatic, presenting symptom whether dyspnea or stridor and number of intubation days and number of days before the onset of symptoms.

Patients had been examined for general and local chest examination to evaluate chest condition and other associated lung pathologies. Complete blood count, Liver function tests, Kidney function tests, Coagulation profile and CT with 3D reconstruction to evaluate the site, length, diameter of stenotic segment and its distance from carina and vocal cords had done. ECG and Echocardiography if needed were done to any patient above 50 years who would be candidate to general anesthesia. Preoperative bronchoscopy had done to confirm the stenotic segment site, length and distance from carina and vocal cords, exclude tracheomalacia, asses the severity of stenotic segment and mucosal inflammation.

Intervention techniques:**Bronchoscopic Dilatation in operative room.**

Pre-operative we do endoscopic evaluation of the larynx and the trachea in all patients to evaluate the tracheal mucosa, the vocal cords and for the assessment of the location and the length of the stenosis. Confirm healthy tracheal mucosa proximal and distal, exclude mucosal ulceration, to do tracheal dilatation to facilitate intubation during the induction.

Preparation:

The patients were lying in Supine position with flexion of the neck by putting a large towel under the shoulders. The patient is exposed from chin to xiphoid process in case sternotomy is required.

Tracheal resection is conducted under general anesthesia which is challenging for both surgeon and anesthesiologist. Continuous close communication between the surgical and anesthesia teams is required .Small diameter endotracheal tubes (from 4.0 to 6.5) should be available .placement of an arterial line, one or two midsized peripheral IV cannula.In selected cases, slow inhalational anesthesia maintaining spontaneous ventilation is valid for high degree of air way obstruction. The surgeon should have available an array of rigid bronchoscopes from pediatric to

adult sizes as the induction begun .At the time of tracheal division, the endotracheal tube is pulled back under direct vision. To maintain ventilation a sterile cuffed endotracheal tube is inserted into the distal airway across the operative field. Sterile connecting tubing is passed to the anesthesiologist to allow ventilation of the patient. This tube is removed whenever necessary for suctioning or placement of sutures. The use of cardiopulmonary bypass is rarely necessary in adult tracheal surgery, but it may be required in some complex carinal reconstructions.

Surgical technique:

In case of the lesion dose not exceed the half the tracheal length and the mucosa of distal tracheal is healthy, the lesion is resectable. Under general anesthesia we do first rigid bronchoscopy to dilate the tracheal stenosis to make the intubation easy to do with the possible large endotracheal tube.

If the lesions are Proximal in the trachea we do collar incision. Skin flaps are elevated. The dissection is sharp around the trachea to mobilize it and avoid to harm the blood supply and the recurrent laryngeal nerve (RLN). The use of bipolar diathermy is advised to reduce the thermal injury to the RLN.

The distal tracheal lesions are reached via both cervical and manubriotomy approach. Just in case of long segment stenosis and in cases of carinal stenosis the sternum is opened. A releasing maneuvers either simple flexion of the neck and digital release or suprahyoid release or hilar release with the inferior pulmonary ligament division according to the location and the severity of the lesion. After complete resection of the trachea, an endotracheal tube is passed in the distal trachea, back ventilation.

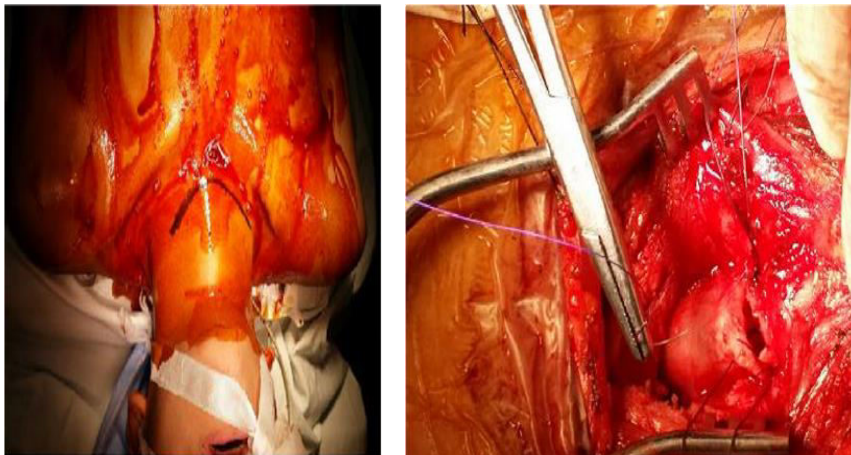


Figure (1) **A**-Marker of collar incision **B**- suturing of anterior tracheal wall

After resection, the posterior tracheal wall is repaired using continuous sutures (polydioxanone) (PDS 3/0). An endotracheal tube is then passed beyond the anastomosis, which is completed in an interrupted manner.

After the trachea is reconstructed, an anastomotic leakage test is done. This is done by flooding the area around of the anastomotic site with saline, deflating the cuff of endotracheal tube. If no bubbles are seen, the wound is closed in layer with suction drain in pretracheal plane.

Before extubation, a 'guardian' suture is placed from the skin over the manubrium to the submental crease, to keep the neck in flexion position. All patients are extubated. careful

attention to airway suctioning aiming to prevent severe cough, which might stimulate unwanted neck extension.

After extubation, care is taken to check for airway obstruction (which might suggest bilateral vocal cord paralysis) and hoarseness or aspiration (which may be occurred by unilateral vocal cord paralysis).

Postoperative.

Patients are transferred to an intensive care unit for observation of the obstructive symptoms. Feeding is return on postoperative day 1 or 2 (starting with liquids), be careful for the signs of aspiration. On the first day postoperative, patients without complications can be transferred to the ward. Patients are usually stay in the hospital for seven days. If no problems are observed, they go to home after the neck stitches and subcutaneous drains have been removed.

Postoperative parameters:

We follow the patients for recurrence of symptoms and regular follow up at 3, 6, 9 months after surgical intervention. The virtual bronchoscopy is performed at 1 month as follow up imaging. The mortality due to surgical procedure is defined as death within 30 days of intervention or during primary hospital stay. Re-intervention defined as any action performed secondary to post-operative complication

Statistical Analysis

Data were abstracted by the review of clinical records and diagnostic reports. Data were then coded and entered into the statistical package SPSS (Statistical Package for the Social Sciences). Data were summarized using mean \pm standard deviation in quantitative data as well as frequency (count) and relative frequency (percentage) for categorical data. The P values were considered as the following:

- P value > 0.05 = Not significant.
- P value < 0.05 = Significant.

Results

In this study the average age was (33.4 ± 16.1) years old for BMI the mean was (25.4 ± 4.1) kg/m^2 ranged between $(19 \text{ and } 34.6)$ kg/m^2 . 57.5% were males and 42.5% were females. As regards medical history, 15% of the study group had hypertension, 17.5% had diabetes mellitus, and 30% were smokers.

Also that 47.5% of the study group complain stridor, and 22.5% had dyspnea class 2 versus 30% had dyspnea class 3. As regards cause of intubation 50% caused by trauma, 15% had cardiac, and same percentage for shock, 10% of them do intubation because of respiratory, and neurological causes.

For the course of the lesion 62.5% of them had progressive course (progressive dyspnea), versus 37.5% had acute course (stridor). The mean duration of intubation was (19.4 ± 9.3) days, with a mean time interval between extubation and the complaint of (26.9 ± 18.3) days.

Table (1). Virtual bronchoscopy results

Tracheostomy		
No	25	62.5%
Yes	15	37.5%

Others	Mean \pm SD	Range
Segment Length by CT	2.45 \pm 0.71	1-4
distance from vocal cords	3.92 \pm 1.4	2-7
distance from Carina	5.39 \pm 1.7	1-9

During the surgery 80% of the study group do collar incision and 17.5 do collar with manubriotomy incision and 2.5% collar with manubriotomy incision with use of CPB , all cases do simple release. Site of surgical intervention 40% do sub-glottic, 40% do mid tracheal, and 20% do low tracheal incision, all cases need on table extubation. With a mean operation time (53.3 \pm 12) minutes, and mean excised length of (2.64 \pm 0.66) cm.

Postoperative period no cases need for reintubation , with 15% of them show complication 5% complicated with hematoma & wound infection, and 5% with restenosis, 2.5% complicated by surgical emphysema, and 2.5% complicated with a wound infection. The mortality rate was 2.5% of cases.

Discussion

In this study, 40 patients presenting with post intubation tracheal stenosis were managed surgically, 17 female patients (42.5%) and 23 males (57.5%) with mean Age 33.4 \pm 16.1 ranging 15-70 with the main aetiology of tracheal stenosis in all our patients were post intubation and tracheostomy. This has been well established by many authors as a leading causes of tracheal stenosis such as Grillo et al. (1993)

In this study, patients presenting with the predominant symptom stridor (19/40 (47.5%)) where found to have luminal reduction of up to 0.5 cm or less on rigid bronchoscopy while those presenting mainly with dyspnea class 2 (9/40 (22.5%)) and dyspnea class 3 (12/40 (30%)) were found to have luminal diameter 0.5 to 1 cm, patients with luminal diameter more than 1 cm where most likely not symptomatic and hence not included in our study.

This is supported by similar studies done by (Hobai et al. 2012). They regarding the presenting symptom as compared to luminal diameter which stated that dyspnea appeared at diameter 8 mm or less and stridor appeared at diameters 5-6 mm or less.

In the present study, the location of stenosis ranged from 2 to 7 cm from the vocal cord with mean distance of 3.92 \pm 1.4cm, and 1 to 9 from the carina with mean distance of 5.39 \pm 1.7cm. This is more or less similar to the study of (Herrak et al., 2014) who recorded that the site of stenosis from the vocal cords was in average 2.8 cm and from 1 cm extreme to 7 cm. Its distance from the carina was on average 5.12 cm and extremes of 2–8 cm. The mean distance of stenosis to vocal cord by (Ulusan et al., 2018) was 3.41 cm (range, 1.50 to 8.00 cm). The mean length of the stenosis was 2.14 cm with a median of 2.00 cm.

The mean length of the stenotic segment was 2.55 \pm 0.63cm (range: 1 to 4cm). Although the mean length of the stenotic segment in our study was higher than that in the other published studies (Abouarab et al., 2017) (2.55 compared to 2 cm) which is mainly due to the long duration of intubation in the ICU.

In our study, the mean time for intubation in days was 19.4 \pm 9.3 days (range 7-50), which was higher than that observed in the groups in other studies observing the mean intubation time in patients undergoing tracheal resection anastomosis as our study (Zias,Chroneou et al.2008), the median time for intubation was observed to be as high as 50 days for patients presenting with post tracheostomy tracheal stenosis.

In our study the time interval in days between the extubation and the clinical presentation was 26.9 ± 18.3 ranging from 5 to 75 days.

Tracheal stenosis most commonly occurs at the site of the stoma or above the stoma (suprastomal) but below the vocal cords (subglottic). The site of stenosis in the present study was localized subglottic in 17 patients (42.5%), in the mid trachea in 16 patients (40%), in the lower trachea in 8 patients (20%). In cope with (Sue and Susanto, 2003) .

Regarding bronchoscopic dilatation the mean was 2.40 ± 0.95 time ranging (1 to 5 time) with mean interval between the sessions was 12.5 ± 7.8 days ranging (3 to 30 days) .

For the surgical method, we did the basic principles of tracheal reconstruction introduced by authors with large experience (Grillo et al., 1993) These methods include avoidance of anastomosis tension, maintenance of tracheal blood supply and preservation of recurrent laryngeal nerve with careful and meticulous dissection and anastomosis. We employed the use of polydioxanone (PDS) 3-0 sutures with continuous suture line of the posterior tracheal wall and interrupted sutures for the anterior wall which proved to produce less post-operative residual stenosis as compared to continuous sutures alone.

Regarding the surgical incision 32 patients (80%) needed collar incision, 7 patients (17.5%) needed collar and manubriotomy and 1 patient (2.5%) needed collar and manubriotomy with use of CBP through femor`-femoral bypass.

In our study, patients needed some form of a release incision and mobilization to have a safe tension-free anastomosis in the form of simple (anterior) release. Mohsen et al. (2018) who found that 85% of patients needed release incision and mobilization However their study was done only on patients with long segment tracheal stenosis more than 4 cm but in our study the stenotic tracheal segment was variable short & long segments, ranging from 1 to 4 cm.

All patients who underwent tracheal resection anastomosis in our study had satisfactory results (95% of the study group), with 38 patients showing excellent results (non-symptomatic without radiological stenosis) and 2 (5%) with restenosis (symptomatic with post-operative radiological stenosis on 1 month follow up CT). They were managed using permanent tracheostomy. These results are comparable to those published by Grillo et al.(1993) as well as Morcillo et al. (2013).

In our results, the surgery was successful in 38 patients (95%), they had patent airway. This is similar to Mohsen et al. (2018) where 86% of the patients were symptom free after the operation.

Tracheal resection followed by end-to-end anastomosis is now a well-established technique which when performed under well-established indications -According to the literature the success rate would be from 71% to 97%.

There was 1 mortality in our study 1week post-operative due to cardiac cause as tracheal stenosis was due to prolonged intubation after CABG, with only 2 patients suffering an adverse major event in the form of severe restenosis following Resection and Anastomosis due to excessive granulation tissue and was adequately managed using permanent tracheostomy. This particular adverse event was described by (Elsayed and Moharram, 2021). They could be reduced by the use of absorbable sutures such as polydioxanone as that employed in our study.

Regarding the complications observed, surgical emphysema was observed in 1 patient (2.5%), no dysphagia and restenosis in two patients (5%). The complications were not statistically different according to the type of definitive management (Fisher's exact $p=0.46$).

The surgical emphysema was mild, observed almost immediately after discharge from the operating theater to the ICU, was non progressing and resolved within 48 hours. it was managed conservatively with no recurrence or major adverse event.

One patient developed wound infection 10 day post-operative , he was diabetic and obese ,he managed with antibiotic drugs and vacuum assisted device for 3weeks till the wound become clean .

Two patients developed wound hematoma after removal of the suction drain, it was managed conservatively with frequent dressing and squeezing the wound, it disappeared after 3 days.

Conclusion

Tracheal stenosis that follows the intubation is a life-fatal situation, although the advance in the conditions and technology in intensive care. We suggest that tracheal resection and reconstruction is the most efficient methods in patients without medical contraindications, despite emergent stent or endoscopic procedures. Endoscopic interventions can be instead of the surgery in patients for whom surgery cannot be performed, high risk patients or who develop a recurrence.

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