Original
ISSN 2521-8492

Post-Traumatic Tracheal Stenosis: Results of Tracheal Reconstruction: A Multicenter Case Series

Aram Bakhtiar Rasool[1], Bashar Hanna Azar[2*], Aram Baram[1,3]

[1]Department of Thoracic and Cardiovascular Surgery, Sulaimani Teaching Hospital, Al Sulaymaniyah, Kurdistan Region, 46001, Iraq.
[2]Department of Surgery, Section of Cardio-thoracic and Vascular Surgery, Hawler Medical University, Erbil, Kurdistan, Iraq.
[3]Department of Surgery, School of Medicine, Faculty of Medical Sciences, University of Sulaimani, François Mitterrand Street, Sulaymaniyah, 46001, Iraq.
*Correspondence to: Bashar Hanna Azar (E-mail: basharsaqat68@gmail.com)
(Submitted: 10 December 2020 – Revised version received: 28 December 2020 – Accepted: 24 February 2021 – Published online: 26 June 2021)

Abstract

Objectives To find out the long-term results of tracheal reconstruction in terms of presentation, operation, complications, and outcomes of tracheal reconstruction.

Methods In this case-series study, the patients who developed post-intubation tracheal stenosis following respiratory failure were followed up for two years for the possible complications. The patients were diagnosed by experienced pulmonologist in two surgical centers, Erbil and Sulaimaniya in Iraqi Kurdistan in 2017.

Results The number of patients who were included in this study was 20; including males (n = 13) and females (n = 7) ranged between 18–58 years. The causes of the stenosis in patients were post-intubation (n = 18) and post-tracheostomy for trauma (n = 5). Most patients underwent extubation after 72 hours. The Myer-Cotton Grade of stenosis were grade 1 (n = 1), grade 2 (n = 13), and grade 3 (n = 6). The major complications were dehiscence (n = 3) and anastomotic edema (n = 5). The minor complications were granulation (n = 13) and mild anastomotic edema (n = 1). One patient developed a surgical site infection and one patient developed a mild infection. The anastomotic fibrin deposition was developed in five patients. All patients had excellent satisfaction except for two patients (unsatisfactory). One of these patients died at month 1. The patients had normal medical conditions at different times of follow-ups.

Conclusion This study showed that the results of the patients with post-traumatic tracheal stenosis were acceptable at different times for most of them.

Keywords Trachea; postintubation stenosis; surgery

Introduction

Post intubation (PI) tracheal stenosis was first determined in 1880 after MacEwen established prolonged endotracheal intubation for four patients with upper airway obstruction. Later, PI stenosis and post tracheostomy (PT) stenosis are rarely reported with deleterious complications and different tracheal stenosis. The incidence of PT stenosis is between 10 and 22% in all intubated patients[1] and between 1% and 2% of the patients are symptomatic or have severe stenosis.[2] The severe PT stenosis is considered to be 4.9 cases per million in a year in the general population.[3]

Prolonged intubation can cause tracheal stenosis at different levels within the trachea. The stenosis can happen at different levels from the level of the endotracheal tube tip up to the glottic and subglottic areas. But, the most common sites of stenosis are where the endotracheal tube cuff has contact with the tracheal wall and at the tracheal stoma site after a tracheostomy procedure. Therefore, tracheal stenosis is categorized into the following two types of airway intubation endotracheal intubation (PI) and tracheostomy (PT).[4]

Few patients of these patients develop postintubation tracheal stenosis (PITS). It could result in ETT intubation or tracheostomy. This stenosis could occur at the larynx, tracheostoma, or at the trachea below the larynx. The capillary pressure is increased in the case of exerting pressure by the inflated cuff. Accordingly, the tracheal mucosa and sometimes the cartilage underneath become ischemic. The ischemic condition may lead to necrosis in prolonged conditions. A change of the "high-pressure-low volume cuffs" to the "high volume-low-pressure cuffs" may decrease its incidence but not eliminated its occurrence.[3]

Tracheal stenosis is classified according to the obstruction degree into the following four grades. Grade 1 – <50% obstruction, Grade 2 – 51%–70% obstruction, Grade 3 – 71%–99% obstruction, and Grade 4 – there is no detectable lumen. The tracheal diameter should be decreased by 75% for a patient to be symptomatic. The lesser digress of tracheal stenosis does not force the patients to seek medical treatment. The patients seek medical treatment when the computed tomography (CT) scans or other imaging are obtained for any reason.[5]

Gerbard et al. explained 150 cases diagnosed with tracheal stenosis.[6] They reported that the causes of tracheal stenosis were iatrogenic (50%), idiopathic (18.5%), autoimmune (18.5%), and trauma (8%). The common comorbidities in iatrogenic strata were cardiovascular comorbidities and type II diabetes mellitus (T2DM) compared to other etiologies. In addition, 66% of the patients need tracheostomy for lifelong.

The necrosis that occurred after healing could result in tracheal stenosis over the next 3–6 weeks. The patients may receive a long segment or a short segment or more likely to follow prolonged intubation. Sometimes, these conditions become tracheo-esophageal fistulas. Chang et al. reported that 133 patients developed tracheal stenosis of the total 218,573 patients who received intubation for surgery.[7] There are few reports of post-traumatic tracheal stenosis in Iraq. Almudhafer et al. followed up with 60 patients with tracheal stenosis who underwent tracheal resection and reconstruction in Basrah thoracic unit between January 2008 and January 2011. They reported that the results were excellent in 62.5%, %, good in 25%, and satisfactory in 12.5%. Postoperatively complications were found in 25%.[8] In this regard, we aimed to find out the long-term results of tracheal reconstruction in terms of

presentation, operation, complications, and outcomes of tracheal reconstruction.

Patients and Methods

Study Design and Assessment

In this case-series study, the patients who developed post-intubation tracheal stenosis following respiratory failure were followed up for two years for the possible complications. The patients were diagnosed by experienced respirologists in two surgical centers in Erbil in Iraqi Kurdistan in 2017.

The patients who were diagnosed with progressive dyspnea were consecutively screened for the eligibility criteria. The cause of dyspnoea was tracheal stenosis in all included patients. The included patients had undergone endotracheal intubation or tracheostomy for respiratory resuscitation after trauma. The patients were males (n = 13) and females (n = 7) aged 18–58 years old.

The data were collected in Rizgary Teaching Hospitals in Erbil and Sulaimaniya Teaching Hospitals. The data were taken directed from the patients and follow-up for the possible complications.

The patients who were diagnosed to have benign tracheal stenosis more than 75% of both genders aged 18 years and older were eligible for the study.

We performed the complete physical and medical examinations from all patients upon attendance. The following investigations were performed for the patients; chest x-rays, C-T scan (sagittal and coronal sections) for the neck and chest. The imaging was done to find out the length, stenosis severity, and vocal cords status. Besides, to delineate the airway below the stenosis because it cannot be done by bronchoscopy. The imaging provides an idea about the cartilaginous support and the surrounding structures. The sputum of the patients was sent for bacteriological examination with a culture and sensitivity test. Pre-operative bronchoscopic examination of the larynx and the trachea was done for all patients. It was done to find out the state of the tracheal mucosa, the vocal cords' status, and the distance up to the stenosis. Besides, it was done to assess the location and the length of the stenosis.

The Grading System of Stenosis

The grading system was performed based on the three factors. The factors were stricture diameter, stenosis type, and clinical symptoms. The patients received the grade based on the above-mentioned factors. Diameter of stricture stenosis rate were rated as 0–25% (score 0); 26–50% (score 1); 51–75% (score 2); 76–90% (score 3); and 91% (score 4). Type of stenosis: was determined based on the type of tissue of the lesion as granulation tissue (score 1); granulation tissue, fibrosis and inflammation (score 2); fibrosis (score 3); and malacia (score 4). The clinical symptoms were rated as dyspnea only during intense activity (score 1); dyspnea during normal activity but the physical examination was normal (score 2); long inhalation and exhalation but with no stridor or retraction (score 3); and presence of stridor and retraction (score 4).[9]

Levels of Stenosis

The sites of the stenosis were recognized in mid-cervical tracheal stenosis; lower-cervical tracheal stenosis; or mid & lower cervical tracheal stenosis. Besides, the prestomal stenosis and multiple stenosis areas were diagnosed in intubated patients. The levels of stenosis were determined in the percentage of reduction of the lumen.

Follow-up

The general information of the patients was recorded in a pre-designed questionnaire; including age, gender, medical conditions, and contact. The patients were followed up by phone call. In addition, we performed the medical and physical examinations for patients for months 1, 3, 6, 9, 12, and 24. The following complications were documented during the follow-up time; dehiscence, anastomotic edema, granulation, etc. The satisfaction of the patients was recorded as excellent satisfaction, satisfaction, and satisfaction. The patients received antibiotic and steroid inhalational therapy preoperatively for temporary palliative airways opening and preoperative bronchoscopic dilatations.

Statistical Analysis

The general information of the patients was presented in number (percentage) and mean (Sta. deviation). The complication and outcomes of the patients at different times of the follow-up were determined in number. The SAS JMP Pro 14.3 was used for the statistical calculations.

Ethical Considerations

The ethical approval of the present study was obtained from Kurdistan Board for Medical Specializations. In this study, we did not apply any intervention to the patients. Only the patients were followed up for the possible complications.

Results

The number of patients who were included in this study was 20; including males (n = 13) and females (n = 7). The mean age of the patients was 35.75 (SD: 11.72) ranged between 18 and 58 years. The patients had ASA I (n = 10), ASA II (n = 6), and ASA III (n = 4). The patients had CVD (n = 1), hypertension (n = 1), psychotic disorder (n = 1), and T2DM (n = 1) and were heavy smokers (n = 6). We found that 10 of the patients had not any commodity. Most of the patients had normal lab investigations (Table 1).

The causes of the stenosis in patients were post-intubation (n = 18) and Post-tracheostomy for trauma (n = 5). Most patients stayed in ICU for 72 hours, except one patient for seven days, and received extubation after 72 hours. The Myer-Cotton Grade of stenosis were grade 1 (n = 1), grade 2 (n = 13), and grade 3 (n = 6). The stenosis was common in mid and lower cervical tracheal or lower cervical tracheal, or mid-tracheal sites. Prestomal stenosis was observed in two cases only. Multiple tracheal stenosis areas was seen in one case and died accordingly. The stenosis level was different from 60% to 95% reduction of lumen (Table 2).

The major complications were dehiscence (n = 3) and anastomotic edema (n = 5). The minor complications were granulation (n = 13) and mild anastomotic edema (n = 1). One patient developed a surgical site infection and one patient developed a mild infection. They were treated as appropriate. The anastomotic fibrin deposition was developed in five patients (Table 3). All patients had excellent satisfaction except for two patients (unsatisfactory). One of these patients died at month 1. The patients had normal medical conditions at different times of follow-ups.

Table 1. **General information of patients with post-traumatic tracheal stenosis**

Case	Gender	Age	ASA	Comorbidities	Lab Investigations		
					CBC	RFT	Blood Glucose
1	Male	34	1	Heavy Smoker	Normal	Normal	Normal
2	Male	48	1	Heavy Smoker, hypertension, T2DM	Normal	Normal	Normal
3	Female	18	1	Psychotic disorder	Normal	Normal	Normal
4	Male	25	1	Heavy Smoker	Normal	Normal	Normal
5	Female	40	1	Heavy Smoker	Normal	Normal	Normal
6	Female	22	3		Normal	Normal	Normal
7	Male	48	3	T2DM	Normal	Normal	Abnormal
8	Female	55	3	Hypertension	Normal	Normal	Normal
9	Female	22	2		Normal	Normal	Normal
10	Male	38	2		Normal	Normal	Normal
11	Male	58	2		Normal	Normal	Normal
12	Male	39	3	CVD	Normal	Normal	Normal
13	Female	33	2		Normal	Normal	Normal
14	Male	45	2		Normal	Normal	Normal
15	Male	22	2		Normal	Normal	Normal
16	Male	21	1		Normal	Normal	Normal
17	Male	35	1		Normal	Normal	Normal
18	Male	45	1	Heavy Smoker	Normal	Normal	Normal
19	Male	32	1	Heavy Smoker	Abnormal	Normal	Normal
20	Female	35	1		Normal	Normal	Normal

Table 2. **Causes and grades of the stenosis and ICU stay**

Case	Cause of stenosis		Myer-Cotton grade	Stenosis site	Stenosis level	ICU stay	Extratubation
	Post-intubation	Post-tracheostomy for trauma					
1	Yes	Yes	2	4 cm mid & lower cervical tracheal stenosis	75% reduction	72	72
2	Yes		3	3 cm mid cervical tracheal stenosis	80% reduction	72	72
3	Yes		3	4 cm mid cervical tracheal stenosis	85% reduction	72	72
4	Yes		2	3 cm lower cervical tracheal stenosis	85% reduction	72	72
5	Yes		2	3 cm lower cervical tracheal stenosis	60% reduction	72	72
6	Yes		2	3 cm lower cervical tracheal stenosis	60% reduction	72	72
7		Yes	2	Prestomal stenosis		48	72
8	Yes	Yes	2	Prestomal stenosis and large amount of granulation tissue		72	72
9	Yes		3	Tight membrane like stenosis of mid trachea		72	72
10	Yes		2	3 cm lower tracheal tight stenosis		72	72
11	Yes		2	5 cm mid-tracheal tight stenosis		72	72
12	Yes		2	4 cm mid-tracheal tight stenosis		72	72
13	Yes		2	6 cm mid-tracheal tight stenosis		72	72
14	Yes		2	5 cm mid-tracheal tight stenosis		72	72
15	Yes	Yes	1	5 cm mid-tracheal tight stenosis		72	72
16		Yes	3	3.5 cm post-laryngeal tracheal stenosis	95% reduction	24	72
17	Yes		2	2.5 cm lower cervical tracheal stenosis		48	48
18	Yes		2	3.5 cm lower cervical tracheal stenosis	75% reduction	48	48
19	Yes	Yes	3	Multiple tracheal stenosis areas	85% reduction	168	0
20	Yes		3	3 cm lower cervical tracheal	85% reduction	48	48

Table 3. **Major and minor complication**

Case	Major complications		Minor complications		Temporary vocal cord dysfunction	
	Dehiscence	Anastomotic edema	Granulation	Mild anastomotic edema	Wound infection	Anastomotic fibrin deposition
1					Superficial SSI	
2		Yes			0	Yes
3			Yes		0	Yes
4			Yes		0	
5			Yes		0	
6			Yes		0	
7	Yes		Yes		0	
8			Yes		0	
9			Yes		0	
10			Yes		0	
11					0	
12		Yes			0	
13					0	
14					0	
15					0	
16			Yes		0	
17		Yes	Yes		Mild infection	
18		Yes	Yes		0	Yes
19	Yes	Yes	Yes	Yes	0	Yes
20	Yes		Yes		0	Yes

Discussion

This study found that post-intubation is the most common cause of stenosis followed by post-tracheostomy for trauma. The major complications are dehiscence and anastomotic edema. The minor complications were granulation and mild anastomotic edema. Only one patient developed a surgical site infection and one patient developed a mild infection. The anastomotic fibrin deposition was developed in five patients. All patients had excellent satisfaction except for two patients (unsatisfactory). One of these patients died at month 1. The patients had normal medical conditions at different times of follow-ups.

The long-term results of tracheal reconstruction in terms of presentation, operation, complications, and outcomes of tracheal reconstruction have been explored in other studies as well. For example, Nouraei et al. (2007) assessed the results of primary endoscopic treatment of adult postintubation tracheal stenosis in a comparative study. In this regard, they treated 62 patients with initial endoscopic surgery and followed up for the outcomes. The average stenosis height was 18 mm between 5 and 55 mm. in addition, they reported that most of the lesions were Myer-Cotton grades III or IV (82%). The patients in our study had fewer height stenosis lesions. In our study, 95% had grade II and III, and the remaining 5% had grade I. they reported that the Lesion height and intubation-to-treatment latency independently predict the successfulness of endoscopic surgery.[10] Also, Ulusan et al. (2018) followed-up 22 patients who were treated with tracheal resection and reconstruction due to PITS in a retrospective study. They reported that the mean tracheal stenosis length is 2.14 cm. They did not find postoperative complications in 12 cases and no recurrence was developed during the long-term follow-up in 15 cases (68.2%). However, two patients died (9.1%) at the early stages after surgery and five patients received stent inserted owing to restenosis.[11] In our study, only one patient died in the first month. In addition, one patient developed a surgical site infection and one patient developed a mild infection.

The prevalence of PITS development following intubation or tracheostomy is between 10 and 19%. Less than one percent of patients develop substantial stenosis.[12,13] The segment length is determined to be one of the main issues in tracheal surgery. Tension on the anastomosis rises in the case of increasing resection length and leads to unexpected results. The main reason for determining the anastomosis length is to decide whether a tracheostomy must be performed or not.[11]

Surgical reconstruction is considered to be the gold standard therapeutic method for PITS.[14] Hermes Grillo conducted more than 500 tracheal reconstructions for postintubation stenosis. They obtained good or satisfactory results in 93.7% of the patients, failure in 3.9%, and mortality in 2.4%.[15]

The following points were made by Eti Ajit et al. to decrease the rate of tracheal stenosis. The incidence of tracheal stenosis can be decreased by preventing trauma during intubation through the following techniques; using sufficient sedation or muscle relaxant during intubation; avoiding using large-sized endotracheal (ETT) tube (>8 mm in men and >7 mm in women); maintaining good oral hygiene in intubated patients. Maintenance can be done using oral antiseptics

like oral chlorhexidine, regular oral, and ETT suctioning. In addition, anti-reflux measures should be undertaken to prevent micro-aspiration. Approaching swift hemodynamic stabilization is considered to be an important factor in hypovolemic shock patients.[16]

The success rate in our study was 90%. Only two patients were not satisfied with the outcomes and one patient died in the first month. Wright et al. (2004) reported a success rate of 68.2%. The unsuccessful intervention rate was 22.7%.[15]

Conclusions

This study showed that tracheal reconstruction is a satisfactory surgical technical in terms of complications and outcomes; including stenosis. The most common causes of post-traumatic tracheal stenosis were post-intubation and post-tracheostomy for trauma. Therefore, the results of the patients with post-traumatic tracheal stenosis are acceptable at different times for most of the patients.

References

1. Zias N, Chroneou A, Tabba MK, et al. Post tracheostomy and post intubation tracheal stenosis: report of 31 cases and review of the literature. BMC pulmonary medicine. 2008;8(1):1-9.
2. Dutau H, editor Tracheal stenosis endoscopic treatment. Proceedings of the 12th world congress for bronchology, 2002; 2002: Monduzzi Editore.
3. Nouraei S, Ma E, Patel A, Howard D, Sandhu G. Estimating the population incidence of adult post-intubation laryngotracheal stenosis. Clinical otolaryngology: official journal of ENT-UK; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery. 2007;32(5):411-2.
4. Poetker DM, Ettema SL, Blumin JH, Toohill RJ, Merati AL. Association of airway abnormalities and risk factors in 37 subglottic stenosis patients. Otolaryngology—Head and Neck Surgery. 2006;135(3):434-7.
5. V. McCaffrey T. Classification of laryngotracheal stenosis. The Laryngoscope. 1992;102(12):1335-40.
6. Gelbard A, Francis DO, Sandulache VC, Simmons JC, Donovan DT, Ongkasuwan J. Causes and consequences of adult laryngotracheal stenosis. The Laryngoscope. 2015;125(5):1137-43.
7. Chang E, Wu L, Masters J, et al. Iatrogenic subglottic tracheal stenosis after tracheostomy and endotracheal intubation: A cohort observational study of more severity in keloid phenotype. Acta Anaesthesiologica Scandinavica. 2019;63(7):905-12.
8. Almudhafer MM, Ai-Hassani FA, Benyan A-KZ. Surgical management of benign tracheal stenosis in Basrah. Qatar medical journal. 2013;2013(1):9.
9. Ghorbani A, Dezfouli AA, Shadmehr MB, et al. A proposed grading system for post-intubation tracheal stenosis. Tanaffos. 2012;11(3):10.
10. Nouraei SAR, Ghufoor K, Patel A, Ferguson T, Howard DJ, Sandhu GS. Outcome of endoscopic treatment of adult postintubation tracheal stenosis. The Laryngoscope. 2007;117(6):1073-9.
11. Ulusan A, Sanli M, Isik AF, Celik İA, Tuncozgur B, Elbeyli L. Surgical treatment of postintubation tracheal stenosis: A retrospective 22-patient series from a single center. Asian journal of surgery. 2018;41(4):356-62.
12. Stratakos G. Postintubation tracheal stenosis and endoscopic management. Pneumon. 2003;16(3):262-70.
13. Wain JC. Postintubation tracheal stenosis. Chest Surgery Clinics. 2003;13(2):231-46.
14. Tsakiridis K, Darwiche K, Visouli AN, et al. Management of complex benign post-tracheostomy tracheal stenosis with bronchoscopic insertion of silicon tracheal stents, in patients with failed or contraindicated surgical reconstruction of trachea. Journal of thoracic disease. 2012;4(Suppl 1):32.
15. Wright CD, Grillo HC, Wain JC, et al. Anastomotic complications after tracheal resection: prognostic factors and management. The Journal of thoracic and cardiovascular surgery. 2004;128(5):731-9.
16. Shenoy L, Nileshwar A. Postintubation tracheal stenosis: A devastating complication! Indian Journal of Respiratory Care. 2019;8(2):69.