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Surgical management of patients with post-intubation tracheal stenosis (PITS): A single center experience

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Abstract

Post-intubation tracheal stenosis(PITS) is observed in patients who are hospitalized in the intensive care unit due to various etiological reasons and who are exposed to prolonged intubation during follow-up as a result of the pressure applied to the tracheal mucosa to cause necrosis or scarring in the trachea. In our study,we aimed to retrospectively evaluate the results of patients who underwent dilatation with rigid bronchoscopy and those whose conditions did not improve despite dilatation and underwent tracheal resection and reconstruction, and compare the with the literature. This study was conducted to retrospectively analyze the data of 20 patients who underwent surgical intervention due to PITS between 2019-2022.The patients were divided into 2 groups according to the Cotton Myer PITS index of the data obtained as a result of measuring the diameter of the stenotic tracheal segment according to bronchoscopic and CT measurements. When the patients were classified according to the post-intubation tracheal stenosis classification described by Cotton Myer,it was seen that 7 patients were Grade 1.10 patients were Grade 2 and 3 patients were Grade 3. Tracheal resection and reconstruction surgery is a difficult procedure and requires surgical experience due to the lack of experienced anesthesia team in every center.For this reason,we recommend sequential bronchoscopic dilatation in patients with comorbidity who are not suitable for tracheal resection and in grade 1 patients. However, we suggest that tracheal resection and reconstruction surgery should be performed after appropriate preoperative preparation in patients with grade 2 and 3 without co-morbidity.

Keywords: Post-intubation tracheal stenosis (PITS), bronchoscopic dilatation, tracheal resection

Introduction

Symptomatic tracheal stenosis is observed in patients who are hospitalized in the intensive care unit due to various etiological reasons and who are exposed to prolonged intubation during follow-up as a result of the pressure applied to the tracheal mucosa to cause necrosis or scarring in the trachea. The incidence of tracheal stenosis after intubation (PITS) ranges between 0.6-21% [1,2]. The most common symptom in patients with PITS is dyspnea on exertion. Posteroanterior chest X-ray, computed tomography of the thorax and/or diagnostic rigid or flexible bronchoscopy can be used, if possible, to confirm the diagnosis of PITS, especially in patients who check into the clinic with stridor-type dyspnea after prolonged intubation. Surgery is not appropriate for patients with comorbidities, characteristics of stenosis and restenosis after resection, although tracheal resection and reconstruction is a highly recommended treatment approach for patients diagnosed with PITS. Before performing the resection, bronchoscopy for dilatation is applied to the patients in order to reduce their symptoms and prepare them for the resection procedure. One study found that bronchoscopic interventions applied to inoperable patients with high comorbidity were curative [3]. In our study, we aimed to retrospectively evaluate the results of patients who underwent dilatation with rigid bronchoscopy and those whose conditions did not improve despite dilatation and underwent tracheal resection and reconstruction, and compare with the literature.

Materials and Methods

This study was conducted to retrospectively analyze the data of 20 patients who underwent surgical intervention due to PITS between 2019-2022. Patients' age, gender, etiology, postoperative hospital stay, number of bronchoscopic dilatations were evaluated by hospital data, stenotic tracheal segment length, antero-posterior

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and transverse diameter length of the narrowest part of the stenotic tracheal segment were measured by bronchoscopy and computed tomography. The patients were divided into 2 groups according to the Cotton Myer index of the data obtained as a result of measuring the diameter of the stenotic tracheal segment according to bronchoscopic and CT measurements. Table 1 shows the Cotton Myer PITS Classification [4].

- **Group A:** Patients with CCI=0-1 Grade 2 and Grade 3
- **Group B: 1.** Grade 1 patients,
- **2.** Grade 2 patients with CCI≥3

Only bronchoscopic dilatation was performed in patients with Grade 1 according to the Cotton Myer index of the stenotic segment and Grade 2 patients whose comorbidities were not suitable for tracheal resection and reconstruction. Tracheal resection and reconstruction were performed in grade 2 and 3 patients without comorbidities. Surgical images of one of the patients who underwent tracheal resection and reconstruction are shown in figures 1 and 2. A laryngeal mask was used to maintain airway continuity in five of the patients who underwent tracheal resection and reconstruction, while endotracheal intubation was applied to four others.

In a standard manner, the follow-up of the patients was carried out on the 1st, 3rd and 6th months.

Since there were no volunteer patients in the study and it was retrospective, a patient consent form was not prepared.

Results

Of 20 patients diagnosed and treated for PITS, 13 (65%) were male and seven (35%) were female. Tracheal resection and reconstruction were performed after tracheal dilatation with bronchoscopy in nine (45%) of the patients while 11 (55%) patients underwent only dilatation with bronchoscopy. When the patients were classified according to the post-intubation tracheal stenosis classification described by Cotton Myer, it was seen that 7 patients were Grade 1, 10 patients were Grade 2 and 3 patients were Grade 3. There were no Grade 4 patients. According to this classification, patients with grade 1 were followed up only with bronchoscopic dilatation and no problems were detected in their follow-up. Grade 2 patients were divided into 2 groups. Resection was performed in 6 patients with a Carlson comorbidity index (CCI) of 0 or 1, and bronchoscopic dilation was performed in 4 patients with a CCI value of 3 or more. 2nd grade all 4 patients who underwent bronchoscopic dilation had Diabetes Mellitus, Hypertension and Chronic Renal Failure (CRF) and these comorbidities were not suitable for tracheal resection and reconstruction surgery. Detailed demographic data of the patients are shown in Table 2. The symptoms that occur with the groups obtained as a result of the classification of the patients according to the diameter of the stenotic segment occurring after PITS were examined. In group A patients followed up with tracheal resection, the most common preoperative symptom was dyspnea in 5 patients (55.6%), while in patients in group B. When the relationship between the length of the stenotic tracheal segment of the patients and the surgical procedure performed was examined, the mean length of the stenotic tracheal segment was 25.55±5.68mm in patients in group A, and 27.72±10.67mm in patients in group B. In addition, the mean measurement value of the narrowest part of the anteroposterior and transverse diameters of the stenotic tracheal segment was measured narrower in group B than in group A. Tracheal resection and reconstruction were applied to patients who underwent resection, following the application of dilatation with bronchoscopy an average of 2.22±1.48 times before resection. The detailed analysis of the data obtained as a result of the classification of the patients according to the stenotic tracheal segment diameter is shown in Table 3. In addition, restenosis developed in only 1 of the patients who underwent tracheal resection and reconstruction. Tracheal stent was applied to this patient. In 2 patients followed up with bronchoscopic dilatation, pneumothorax occurred after the procedure and was treated with tube thoracostomy without any problems.

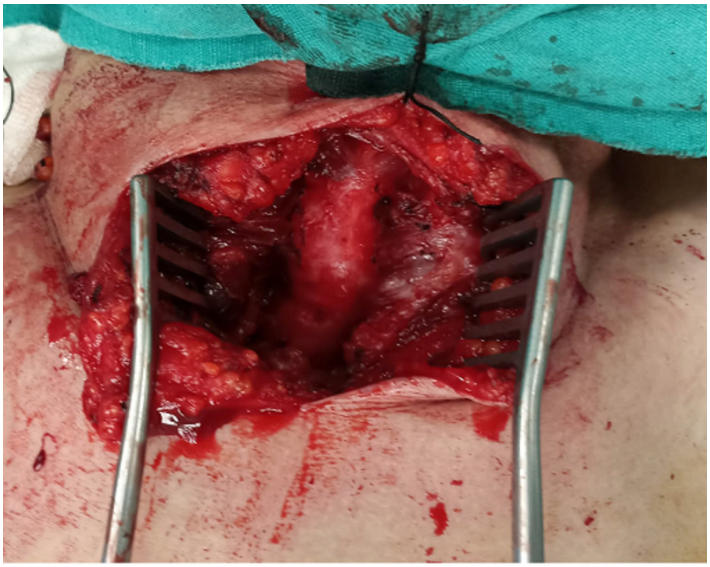

Figure 1. Image of the incision and intraoperative stenotic tracheal segment of the patient to undergo tracheal resection and reconstruction

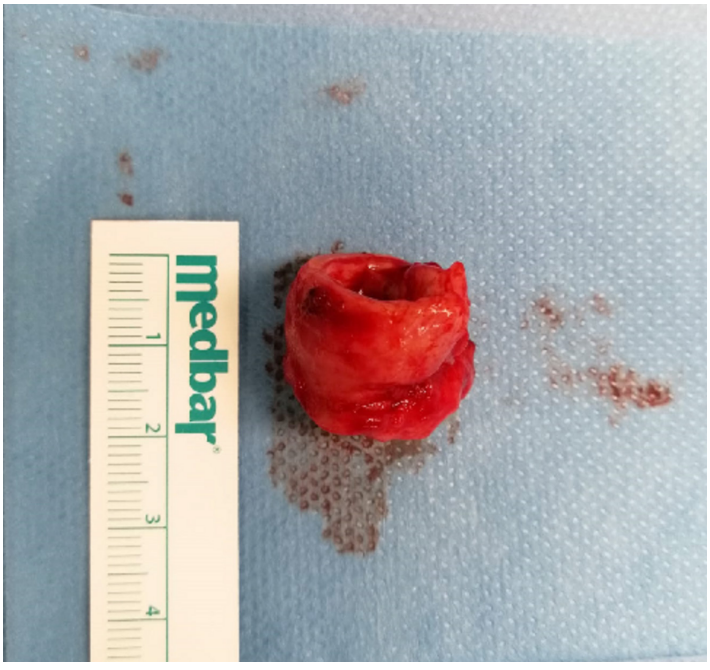

Figure 2: Image of stenotic tracheal segment removed after tracheal resection and reconstruction

Table 1. Cotton Myer PITS classification

GRADE	Percentage of Stenotic Tracheal Segment Diameter
Grade 1	0-50% obstruction
Grade 2	%51-%70 obstruction
Grade 3	%71-%99 obstruction
Grade 4	No detectable lumen

Table 2. Demographic data of patients who underwent surgery for post-intubation tracheal stenosis

Variables		Group A		Group B		Total	
		N	%	N	%	N	%
Gender	Male	5	55.6	8	72.7	13	65
	Female	4	44.4	3	27.3	7	35
Average age (Std±)		40.55±16.41		44.54±11.98			
Etiology	IVMTA	4	44.4	3	27.3	7	35
	Covid-19	1	11.1	6	54.5	7	35
	Status Epilepticus	2	22.2	1	9.1	3	15
	Internal reasons	2	22.2	1	9.1	3	15
Symptom	Stridor	3	33.3	8	72.7	11	55
	Dyspnea	5	55.6	2	18.2	7	35
	Stridor+Dyspnea	1	11.1	1	11.1	2	10
Intubated day (Std±)		13.76±9.50		8.87±0.96			
CCI (Std±)		1.33±1.5		1.90±1.75			

Group A: Patients with CCI=0-1 Grade 2 and Grade 3 with according to Cotton Myer PITS Classification
Group B: 1. Grade 1 patients
2. Grade 2 patients with CCI≥3 with according to Cotton Myer PITS Classification
N: number, Std: Standard deviation, IVMTA: In-vehicle traffic accident, CCI: Charlson comorbidity index

Table 3. Analysis of data obtained as a result of classification of patients according to stenotic tracheal segment diameter

Variables	Group A	Group B
Length of stenotic tracheal segment (Std±)	25.55±5.68mm	27.72±10.67mm
Antero-posterior diameter of the narrowest part of the stenotic tracheal segment (Std±)	6.42±2.34mm	8.22±3.05mm
Transverse diameter of the narrowest part of the stenotic tracheal segment (Std±)	4.71±1.44mm	6.59±2.92mm
Number of bronchoscopic dilatations performed (Std±)	2.22±1.48mm	1.63±0.67mm

Group A: Patients with CCI=0-1 Grade 2 and Grade 3 with according to Cotton Myer PITS Classification
Group B: 1. Grade 1 patients
2. Grade 2 patients with CCI≥3 with according to Cotton Myer PITS Classification

Discussion

Tracheal resection and reconstruction is the most successful treatment method in patients with PITS, although it is not feasible for all patients. The comorbidities of the patients constitute the biggest obstacle to surgery. Therefore, sequential bronchoscopy for dilatation is applied to patients for whom applying tracheal resection and reconstruction is not practical. In a study conducted by Özdemir et al. [5] on 42 patients, only 23 had only a bronchoscopy, whereas resection was applied to 19 of them. Similarly, in our study, only bronchoscopy was performed in 11 patients, and surgery was performed after dilation with bronchoscopy in nine.

Although dyspnea is the most common symptom in PITS patients, stridor may be observed due to the decrease in the diameter of the tracheal lumen [6]. Dyspnea occurs if the tracheal lumen diameter is below 8mm, and stridor occurs if it is below 5mm [7]. In our study, the most common symptom was stridor, which was found in 11 patients (55%).

There is no definitive algorithm in the literature for the treatment of PITS. The health centers make decisions based on their own experience and the clinical condition of the patients. The success rate of tracheal resection and reconstruction applied to these patients has been reported in the range of 70-95% [8,9]. In our study, we used Cotton Myer's PITS classification while classifying the patients. Grade 1 patients were followed up with bronchoscopic dilatation. We performed at least 2 bronchoscopy dilatation followed by tracheal resection and reconstruction in grade 2 and grade 3 patients without comorbidities. Although only one patient had comorbidities due to chronic obstructive pulmonary disease (COPD) and diabetes mellitus (DM), tracheal resection and reconstruction were successfully performed because the transverse diameter of the stenotic tracheal segment was measured to be 2.5mm at the narrowest point, and it did not respond to tracheal dilatation with bronchoscopy. Grillo et al. [5] reported that from their study the failure rate as 3.7% in patients who underwent surgery. In our study, only one (11.1%) of nine patients who underwent surgical resection developed restenosis in the first month after the operation, and tracheal stent was applied after not responding to bronchoscopic dilatations.

In a study conducted by Gallucio et al. [10], the success rates of bronchoscopic mechanical dilatation procedure applied in simple and complex stenosis was reported to be 96% and 69%, respectively.

Another study shared that the bronchoscopic mechanical dilatation procedure applied to patients with complex stenosis without comorbidity and patients with a stenotic segment shorter than 1cm achieved a 100% success rate [4].

Mandour et al. [11] found success in 87% of the bronchoscopic dilatation group consisting of 13 patients and 100% in the surgery group of 15 patients in their study in which they compared bronchoscopic mechanical dilatation and surgery in patients with tracheal stenosis.

Jiang L. et al. [12] discussed the advantages of using a laryngeal mask in their study. They stated that the use of a laryngeal mask instead of intubation by anesthesia before tracheal resection and reconstruction made the trachea more flexible, and anastomosis was easier to perform than it would be on intubated patients during the reconstruction phase. We performed tracheal resection and reconstruction by maintaining the continuity of the airway with the help of a laryngeal mask in five (55.5%) of the patients that had resection.

Statistically, separation, granuloma, and restenosis is likely to develop at the anastomotic line in 9-20% of patients who have undergone tracheal resection [13]. Patients with restenosis can usually be treated with serial bronchoscopic dilatations following the occurrence of stridor with increasing severity over a long period of time [14]. Tracheal stent can be applied in patients who do not improve with dilatation. In one of our patients (11.1%), we had to apply a tracheal stent because the stridor did not regress, despite bronchoscopic dilatations after resection.

Limitations of the Study

The main limitations of this study are its retrospective nature, the fact that it was conducted at a single center, the small number of patients, and the inability to conduct long-term survey analysis due to the recent period of time being considered.

Conclusion

The best treatment option in patients with benign tracheal stenosis is tracheal resection and reconstruction. However, tracheal resection and reconstruction surgery is a difficult procedure and requires surgical experience due to the lack of experienced anesthesia team in every center. For this reason, we recommend sequential bronchoscopic dilatation in patients with comorbidity who are not suitable for tracheal resection and in grade 1 patients. However, we suggest that tracheal resection and reconstruction surgery should be performed after appropriate preoperative preparation in patients with grade 2 and 3 without comorbidity. Furthermore, we argue that it would be more appropriate to maintain airway continuity with a laryngeal mask instead of intubating the patients with an endotracheal tube during the operation in order to minimize the postoperative complications and the success of the surgical anastomosis in patients who undergo tracheal resection and reconstruction.

Conflict of interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Approval for this study was obtained from the local ethics committee (Date: 06.04.2022, No: E1-22-2554).

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