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CLINICAL STUDY

Tracheal resection and modified T-tube in the treatment of benign tracheal stenosis. A retrospective study of 48 patients

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ABSTRACT

OBJECTIVE: The objective was to prove efficiency of tracheal resection in the cohort of patients of our clinic and to introduce our own modification of T-cannula as a surgical alternative if tracheal resection is contraindicated.

BACKGROUND: Benign tracheal stenosis, the most often represented by post tracheostomy (PTTS) and post intubation (PITS) stenosis, is a rare, but serious and potentially life-threatening medical condition. We present our experience with the management of the patients, who were referred with a benign tracheal stenosis.

METHODS: In the retrospective study, patient's outcome was evaluated after tracheal resection or treatment with T-cannula from all the patients presented with a benign tracheal stenosis from January 2015 to January 2021.

RESULTS: The cohort consists of forty-eight patients. Thirty-one (64,6 %) patients underwent a tracheal resection and seventeen (35,4 %) were treated with tracheostomy and T-tube insertion. In the series of patients after tracheal resection, we observed no mortality, complications occurred in ten (32,2 %) patients. They were spread proportionally; anastomotic complications were noticed in 5 (16,1 %) patients, as well as non-anastomotic complications.

CONCLUSION: Tracheal resection is a safe and effective procedure with good results. T- tube insertion presents a surgical alternative if bronchoscopy is unavailable or failed *(Tab. 4, Fig. 2, Ref. 20)*. Text in PDF *www.elis.sk*

KEY WORDS: tracheal resection, T-cannula, tracheal stenosis.

Introduction

Benign tracheal stenosis (BTS) is defined as abnormal narrowing of the tracheal lumen that can be caused by various factors, except tumours (1). The most common cause of tracheal stenosis is recognized post intubation (PITS) and post tracheostomy (PTTS) obstruction. Incidence of PITS and PTTS stenosis ranges from 4 % to 21 % (2), but only 1 % to 2 % of the patients are symptomatic (3). The estimated incidence of symptomatic PITS and PTTS stenosis in the general population is 4.9 cases per million per year (4).

Prolonged intubation may result in tracheal stenosis due to mechanical damage to the tracheal wall (5). Stenosis can develop at various levels within the trachea, but the most common is the site, where the cannula's cuff was in contact with the tracheal wall (6). The postulated causative factor is the loss of regional blood flow due to cuff pressure on the tracheal wall (7). Tracheal stenosis can also occur at the tracheostomy site. Risk factors of stomal stenosis include sepsis, stomal infection, hypotension, advanced age, male sex, tight-fitting or oversized cannula, excessive tube motion, prolonged placement, and disproportionate excision of anterior tracheal cartilage during the creation of the tracheostomy (8). Bacterial infection and chondritis at the stoma site leads to weakening of the anterior and lateral walls of the trachea. Stomal granulation tissue develops and narrows the lumen at the site of tracheostomy. Initially, granulations are soft and vascularized, but as they mature, they become fibrous and covered with a layer of epithelium. Due to fibrosis and scar tissue formation, tracheal margins are pulled to the midline, which results in a stenosis creation (9,10).

Despite improvements in tracheostomy and intubation care, surgical treatment of tracheal stenosis remains an integral part of thoracic surgery. Patients diagnosed with a tracheal narrowing must be carefully evaluated before a therapeutic approach is selected. Those with severe comorbidities or significant contraindications to tracheal resection are treated with alternative interventions. If endoscopy is not feasible or available, insertion of T-tube via tracheostomy site is a surgical method of choice.

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Materials and methods

The retrospective study analysed 48 patients referred to Department of Thoracic Surgery, University Hospital Bratislava with BTS from January 2015 to January 2021. The ethical approval for this study was obtained from the local ethical committee. Approval No. EK/159/2021. The most frequent causes of BTS in the cohort were post intubation and post tracheostomy tracheal stenosis. Chest-neck CT scan was considered as a diagnostic entity of choice in the symptomatic patients. According to CT findings and patients' comorbidities, we decided in cooperation with anesthesiologist, about a definitive procedure. The primary therapeutic aim was tracheal resection with reconstruction. If the patients were not suitable for surgery, they underwent tracheostomy and T-cannula or tracheostomy cannula insertion.

Contraindications to surgery are shown in Table 1.

Tracheal resection with reconstruction was performed in thirty-one patients. The surgical technique depended on the location of the stenosis. Cervical incision was predominantly used. Combination with sternotomy was performed in four patients. The resected segment of the trachea was measured. Anastomosis was constructed with interrupted monofilament absorbable sutures (3-0 Biosyn). After surgery, bronchoscopic evaluation of the anastomosis was performed and the patients were extubated. To protect the anastomosis, the neck was fixed in anteflexion. On the day 7th after surgery, a control bronchoscopy was done. If the anastomosis was sufficient, patients were discharged. Following bronchoscopic controls were planned 4 weeks and 6 months after the surgery.

If the patients were not suitable for tracheal resection, they underwent tracheostomy with T-cannula insertion. Procedure was performed under general or local anesthesia according to the medical status of the patient. We used our modified oval-shaped tracheostomy, where the edges of the trachea are sewn to the skin. This type of tracheostomy allows us to perform T-cannula insertion or change under local anesthesia. Our modification of the T-cannula consists of wider and oval-shape horizontal branch. Cleaning and toilet of this type of T-cannula is easier and more convenient than the original one.

Tab. 1. Contraindications of tracheal resection.

Absolute
Non-reconstructable airway (excessive length of stenosis or multilevel stenosis)
Serious comorbidities
Continued need for ventilation
Relative
Previous radiation therapy of the neck
Steroids use
Mucosal inflammation

Tab. 2. Characteristics of patient's groups.

	Gender	Age	Tracheal resection	T-tube
PTTS	F–7	65.4±10.9	1 (2.1 %)	6 (12.5 %)
n=21	M–14	46.4±18.1	10 (20.8 %)	4 (8.3 %)
PITS	F–10	51.3±16.7	8 (16.7 %)	2 (4.2 %)
n=24	M–14	47.8±19.1	11 (22.9 %)	3 (6.2 %)
Postinfection	F–1			1 (2.1 %)
Idiopathic	F–1		1 (2.1 %)	
Posttraumatic	M–1			1 (2.1 %)
Overall (n=48)		50. 4±17.9	31 (64.6 %)	17 (35.4 %)

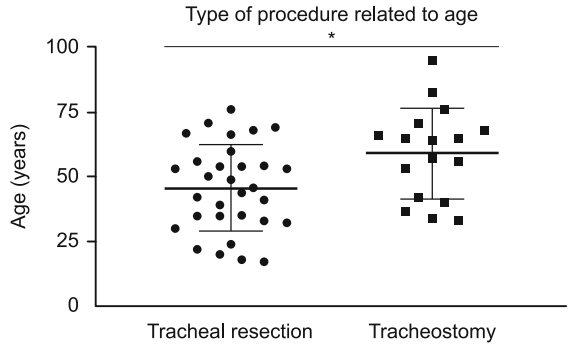

Fig. 1. Type of Procedure Related to Age.

Numerical data are presented as the means and standard deviations and were compared using the Chi-square or the Mann-Whitney test. p values below 0.05 were statistically significant. Statistical analyses were performed using GraphPad Prism (version 8.0; GraphPad Software, Inc.)

Results

Characteristics of the patients' groups are presented in the Table 2. Nineteen (39.5 %) of the patients were female with the mean age of 55.7±15.8 years, and twenty-nine (60.5 %) were male, with the mean age of 46.9±18.4 years (Tab. 2). Older patients were more likely to be contraindicated to tracheal resection (p=0.,022) (Fig. 1).

After admission, patients were evaluated in cooperation with anesthesiologists, and it was decided if they were eligible for tracheal resection. Comorbidities of the individual patients' groups are given in the Table 3. There were defined absolute contrain-

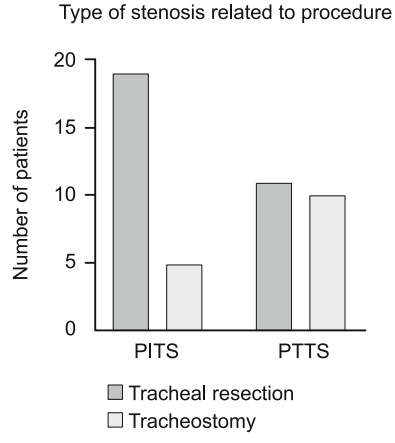

Fig. 2. Type of Stenosis Related to Procedure.

Tab. 3. Patient's comorbidities.

	Post-tracheostomy group Resection/T-tube n = 11/10	Postintubation group Resection/T-tube n = 19/5	Other types of BTS Resection/T-tube n = ½
Diabetes mellitus	1/6 (4.8 %)/(28.8 %)	4/2 (16.7 %)/(8.3 %)	0/1
Cardiovascular disease	3/6 (14.3 %)/(28.8 %)	9/5 (37.5 %)/(20.8 %)	1/0
Recent CPR	2/2 (9.5 %)/(9.5 %)	3/1 (12.5 %)/(4.2 %)	0/0
Chronic obstructive pulmonary disease	0/3 –/(14.3 %)	1/0 (4.2 %)/–	0/0
Alcoholism	1/0 (4.8 %)/–	2/0 (8.3 %)/–	0/0
Obesity	2/2 (9.5 %)/(9.5 %)	1/0 (4.2 %)/–	0/1

dications to tracheal resection: 1. non-reconstructable airways 2. serious comorbidities 3. Continued need for ventilation. Overall, seventeen (35.4 %) patients were contraindicated, ten with PTTS, five with PITS and two with other types of benign tracheal stenosis. We observed a trend, that patients with PITS were more likely to undergo tracheal resection ($p = 0.057$) (Fig. 2).

Due to severe comorbidities, twelve (25 %) patients were contraindicated to resection and underwent tracheostomy and T-tube insertion. As the non-reconstructable airways were considered three of them (6,25 %) patients. One patient (2,1 %) did not undergo surgery due to continuous need for ventilation; a tracheostomy was performed, and a tracheostomy tube inserted. The patient with a post-infection tracheal stenosis received tracheostomy with T-tube. After 8 months, the tracheal wall was reconstructed without the need of resection (Tab. 3).

The group of patients suitable for resection consisted of thirty-one (64.6 %) patients, where eleven patients presented with PTTS, nineteen with PITS and one with idiopathic tracheal stenosis. All the patients underwent a tracheal resection with the mean length of resected segment 3.7 ± 0.8 cm. The surgical approach was predominantly cervical incision in 27 patients (87.1 %), in combination with partial sternotomy in 4 patients (12.9 %). For the mobilization of trachea in all the patients, the pretracheal blunt dissection and fixation of the neck in anteflexion were routinely used. Other types of release manoeuvres were not used. The length of stay of the patients after tracheal resection was 9.6 ± 4.3 days, 8.6 ± 2.8 days in the post-tracheostomy stenosis group respectively 9.8 ± 5.3 days in the group of patients with postintubation tracheal stenosis.

No mortality was observed due to intraoperative or postoperative complications related to tracheal surgery. No death of the patients after tracheal resection within 6 months after surgery was noticed. Complication's rate after tracheal resection was 32.2 %. Non-anastomotic complications developed in five (16.1 %) patients. Four of them (12.9 %) had to undergo tracheostomy in the early postoperative period due to vocal cord and laryngeal oedema. Two patients were decannulated within a few weeks. Another developed further complications and a tracheostomy were retained. Decannulation was planned after the resolution of associated complications. One (3.2 %) patient presented with a respiratory insufficiency within few hours after surgery; an extensive malacia was found during bronchoscopy. Complications were treated with tracheostomy and T-tube insertion to protect anastomosis. After stabilization of the tracheal wall, the patient was decannulated. Anastomotic complications developed in five (16.1 %) patients. One (3.2 %) patient manifested with an anastomotic fistula, which resolved spontaneously within two weeks. In two (6.5 %) patients, a dehiscence of anastomosis was observed. Both cases were treated with tracheostomy and T-tube insertion. There were two (6.5 %) late anastomotic complications found, where a restenosis developed within 2 respectively 4 months. The patients underwent re-resection, but, unfortunately, a dehiscence developed in both cases. Therefore, they received tracheostomy with T-tube insertion. The patient's outcome is presented in Table 4.

Tab. 4. Patient's outcome.

	Patients	Good	T-tube retained (Possible decannulation)	Failure of therapy
Tracheal resection	31	25 (80.6 %)	5 (16.1 %)	1 (3.3 %)

Discussion

PITS and PTTS are the most frequent types of benign tracheal stenosis (11, 12). In our series, these two types represented the major cause of benign tracheal stenosis (93.8 %).

Tracheal resection with end-to-end anastomosis has been established as the gold standard for the treatment of tracheal stenosis. The success rate of this procedure is considered high (71 to 95 %) (13, 14).

Morbidity after the tracheal resection varies from 17 to 45 % and mortality ranges from 0 to 2.4 % (15, 16). Complications are more likely to occur in the patients with diabetes mellitus, laryngotracheal resection, resection longer than 4cm and those, who need a tracheostomy before operation (17). We did not observe a significant correlation between the comorbidities and the incidence of postoperative complications. Even the length of the resected segment did not have a significant impact on the number of complications. However, the small size of the patient's group represented a not negligible bias.

Complications, after tracheal resection, can be considered according to the time they developed and divided into early and late. Some authors divide complications into minor and major (15). We have used the definition to anastomotic and non-anastomotic complications, in the same manner as Wright and colleagues (18).

Several studies have referred the incidence of anastomotic complications. Bibas et al reported anastomotic complications in 21 % of the cases (15). Macchiarini et al reported 34 % of patients with anastomotic complications (air leaks, granuloma, or restenosis) (19). The most recent studies reported the anastomotic complications rate 12.5 % (12), 15 % respectively (20). In our series, we experienced the anastomotic complications in 16.1 % cases, in three patients (9.2 %) they appeared within 30 days and two patients (6.5 %) developed complications after 2, respectively 4 months.

Non-anastomotic complications have been reported by Bibas et al in 23.2 % of cases (15). Sahin et al, who analysed 40 patients after a tracheal resection, reported the non-anastomotic complications in seven patients (17.5 %) (12). In our series, we coped with non-anastomotic complications in 5 patients (16.1 %). The most frequent complication was vocal cord and laryngeal oedema; it developed in 4 patients (12.9 %).

Conclusion

Tracheal resection provides a symptomatic relief from stenosis-associated problems and an improved quality of life. Despite of the complications rate up to 45 %, it is still considered as an effective and safe procedure. In the series we proved this implication, when morbidity and mortality after tracheal resection were comparable to literature.

T-cannula has been used as an adequate alternative for the patients, who could not undergo a tracheal resection, or need it as supportive therapy after the resection. It is considered as a surgical alternative if bronchoscopic intervention is not suitable, available, or has already failed.

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