Efficacy and outcomes of endoscopic management of post-tracheostomy tracheal stenosis: a retrospective study from an interventional center in China

Feng Chen, Jie Zhang, Xiaojian Qiu, Ting Wang, Yinghua Pei

Department of Respiratory Medicine, Beijing Tian Tan Hospital, Capital Medical University, Beijing 100070, China.

Post-intubation or post-tracheostomy tracheal stenosis is the most common cause of acquired benign airway stenosis. Incidence of post-intubation tracheal stenosis (PITS) is decreasing due to the widespread use of the high-volume low-pressure cuff, and awareness of the need to monitor the cuff pressure. Nevertheless, post-tracheostomy tracheal stenosis (PTTS) incidence is still very high and seriously affects the patients’ quality of life. PTTS is often caused by damage to the airway cartilage, regional ischemic necrosis, tracheotomy site infection, and friction between the distal tracheotomy tube and the tracheal wall. Previous studies have reported that surgical resection and reconstruction is the best choice for PTTS management; however, the advent of endoscopic technology has made it a suitable alternative for surgical management, especially for patients with long destroyed tracheal segments or those with severe comorbidities.[1]

Endoscopic treatments for PTTS include stenotic scar excision with high frequency electric surgical knife or laser, balloon dilatation, tracheal stenting, Montgomery T-tube insertion, and more. Choice of treatment is made according to the location, type, degree, and length of the stenosis. This study retrospectively overviewed our past ten-year experience in treating 87 PTTS patients, and analyzed their clinical and stenosis morphological characteristics, treatment details, decannulation rate, and prognosis.

In this retrospective study, we identified 524 patients who were diagnosed with airway stenosis and admitted to our hospital from June 2009 to June 2019. Of these, we identified 87 patients with PTTS. Data on the patients’ baseline characteristics, tracheal stenosis morphological characteristics, treatment details, decannulation rate, and prognosis were collected from the hospital’s electronic medical record system. This study was approved by the Institutional Review Board of Beijing Tian Tan Hospital of Capital Medical University in China (No. KY 2020–042-02) and the requirement to obtain the informed consent was waived.

All procedures were performed under general anesthesia. Patients received intravenous injections of propofol, midazolam, fentanyl, or muscle relaxants according to the specific surgical needs. Procedures were performed with a flexible or rigid bronchoscope. A high-frequency electrosurgical knife or Nd:YAG laser was used to cut the narrowing cicatricial ring; balloon dilatation was used to expand the stenotic segment, and local cryotherapy was administered to reduce the risk of scar restenosis. A high-frequency electric snare was used to treat the intraluminal granulation tissue. A Montgomery T-tube or covered stent was inserted for dynamic airway stenosis to maintain patency of the airway.

Continuous data are presented as mean ± standard deviation for normally distributed data or median (Q1, Q3) for abnormally distributed data. Categorical data are presented as number (percentage). One-way analysis of variance or Kruskal-Wallis H test was used to compare the differences between groups. The Kaplan-Meier model with the log-rank test was used to compare the groups for decannulation rates. Cox regression was used to determine independent predictors for successful endoscopic management. Data were analyzed by IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Differences with \( P < 0.05 \) were considered statistically significant.

The included 87 PTTS patients aged 48.0 ± 17.4 years. Of these patients, 57 were male (65.5%). A history of intubation before tracheotomy was present in 38 (43.7%) patients.

The included 87 PTTS patients aged 48.0 ± 17.4 years. Of these patients, 57 were male (65.5%). A history of intubation before tracheotomy was present in 38 (43.7%) patients.
We made an improvement of Freitag morphological classification of benign central airway stenosis. According to this classification system, 79 patients (90.8%) had tracheal stenosis, and eight (9.2%) had subglottic stenosis. Nearly half of the lesions were scar contractures (45/87, 51.7%), and the stenosis degree (measured by Image J software, National Institutes of Health, Bethesda, MD, USA) ranged from 76% to 90%. Structural stenosis was found in 68 (78.2%) and dynamic stenosis in 19 (21.8%) patients. Stenosis over 50% was found in 73 (83.9%) patients.

All patients received endoscopic operation as the initial treatment. The median (Q1, Q3) number of endoscopic treatments was 2 (1, 3), of which cryotherapy was the most used procedure (60/87, 69.0%), followed by balloon dilatation (34/87, 39.1%), high-frequency electric knife (31/87, 35.6%), and local paclitaxel use (30/87, 34.5%). According to the tracheal stenosis location, we divided the patients into three types: stenosis at the upper end of (Type 1, n = 32), around (Type 2, n = 34), and lower end of (Type 3, n = 21) the tracheostoma. There were no significant differences between the three types in sex, age, and body mass index (P > 0.05). The patients in Type 2 group had the shortest length of tracheal stenosis than the other two types (Type 2 vs. Type 1: 1.00 [0.80, 2.00] cm vs. 1.60 [1.20, 2.35] cm, Z = −2.71, P < 0.01; Type 2 vs. Type 3: 1.00 [0.80, 2.00] cm vs. 2.00 [1.80, 2.70] cm, Z = −3.65, P < 0.01). Successful extubation and airway stability were achieved in 41 patients (47.1%). Kaplan-Meier survival analysis showed that Type 2 patients had the highest decannulation rate (25/34, 73.5%) compared with the Type 1 (9/32, 28.1%) and Type 3 patients (7/21, 33.3%) (P < 0.01).

One death occurred during a surgery in which we tried to remove a bare-metal stent inserted at another hospital. Two patients underwent surgical resection and reconstruction after the endoscopic treatment had failed. Six patients were lost to follow-up. There were 12 primary disease related deaths during the follow-up period. The log-rank test showed that there were significant differences in decannulation rate according to different conditions of local paclitaxel use (P < 0.01), tracheal stenosis type (P < 0.01), consciousness of patients (P = 0.01), location of tracheal stenosis (P < 0.01), and degree of tracheal stenosis (<90% vs. ≥90%) (P < 0.01). Factors remaining independently significant in multivariate Cox regression analysis were the local paclitaxel use and consciousness of patients [Table 1].

Tracheal stenosis is the most common late complication in patients following tracheotomy. In the past decades, open surgical resection was recommended for benign tracheal stenosis, however, operative morbidity and mortality could not be ignored, and restenosis of the anastomotic stoma was one of the main complications in these patients. In previous studies, the success rate of the open surgical approach was up to 90%, accompanied by a 5% to 15% failure rate and a 5% mortality rate.[1] However, open surgical resection and reconstruction probably should not be performed in patients with a long stenotic segment (usually > 5 cm) or severe cardiovascular, respiratory, or neurologic comorbidities.

The success rates of endoscopic management of benign tracheal stenosis vary from 22% to 100% in different pulmonary interventional centers. Patient selection and the discrepancy between surgical techniques might account for these differences. In this retrospective study, only one patient died during the operation, two underwent open surgical management after endoscopic management had failed, and 84 were treated successfully by endoscopic surgery. These findings suggest that endoscopic treatment might be an effective management approach for patients with PTTS, especially those with severe cardiopulmonary dysfunction or who are unwilling to undergo open surgery.

We divided the patients into three types based on the tracheal stenosis location or the most severe stenosis leading to the symptoms if two or three types of stenosis presented simultaneously. The mechanism of airway stenosis differed between the three types. In this study, three patients had Types 1 and 3 stenosis, and one patient had Types 2 and 3 stenosis simultaneously. We primarily treated the stenosis if it affected the patients’ quality of life.

In this study, 18 patients were treated by Montgomery T-tube placement and achieved clinical stability. Patients can restore natural cavity breathing and phonate after T-tube placement, which can significantly improve their quality of life. Montgomery T-tube placement is a good choice for patients with upper tracheal stenosis, especially those with complete or severe tracheal obstruction. The long-term complication following T-tube placement is granulation tissue hyperplasia around its upper and lower edges. Regular endoscopic follow-up can detect and remove the granulation tissue.

A total of 41 patients were successfully extubated and achieved tracheal stability. Type 2 patients had the highest decannulation success rate. Based on Cox regression analysis, predictors of successful endoscopic treatment for PTTS patients included local paclitaxel use and consciousness of patients. To the best of our knowledge, no study has described the prognosis of PTTS, and only one study[5] reported, based on 62 patients with PITS, that early

### Table 1: Multivariate Cox regression analysis of factors associated with endoscopic treatment success rate in PTTS patients.

| Items                             | HR     | 95% CI      | P values |
|----------------------------------|--------|-------------|----------|
| Age                              | 1.49   | 0.67−3.34   | 0.33     |
| Sex                              | 1.07   | 0.50−2.26   | 0.87     |
| Conscious patients                | 2.62   | 1.05−6.56   | 0.04     |
| Local paclitaxel use             | 3.69   | 1.78−7.68   | <0.01    |
| Type 2 tracheal stenosis         | 0.93   | 0.72−1.21   | 0.60     |
| Length of tracheal stenosis      | 0.52   | 0.24−1.15   | 0.11     |
| Tracheotomy to first treatment latency | 0.62   | 0.31−1.22   | 0.17     |
| Location of tracheal stenosis    | 1.36   | 0.83−2.25   | 0.22     |
| Degree of tracheal stenosis      | 0.93   | 0.72−1.21   | 0.61     |

CI: Confidence interval; HR: Hazard ratio; PTTS: Post-tracheostomy tracheal stenosis.
referral to the airway unit and vertical height of the lesion were two predictors for success of endoscopic surgery. Our previous study demonstrated that local paclitaxel use at the stenosis site has a favorable effect on benign tracheal stenosis.[4]

In conclusion, endoscopic surgery may be the first-line and effective treatment for patients with PTTS. Appropriate treatments should be performed according to the location and type of tracheal stenosis. Most patients can benefit from endoscopic treatment, thus reducing the need for open surgery.

Funding
This work was supported by a grant from the Beijing Natural Science Foundation (No. 7202042).

Conflicts of interest
None.

References
1. Tsakiridis K, Darwiche K, Visouli AN, Zarogoulidis P, Machairiotis N, Christofis C, 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. J Thorac Dis 2012;4 (Suppl 1):32–40. doi: 10.3978/j.issn.2072-1439.2012.s002.
2. Rea F, Callegaro D, Loy M, Zun A, Narne S, Gobbi T, et al. Benign tracheal and laryngotracheal stenosis: surgical treatment and results. Eur J Cardiothorac Surg 2002;22:352–356. doi: 10.1016/s1010-7940 (02)00342-1.
3. Nouraei SA, Ghufoor K, Patel A, Ferguson T, Howard DJ, Sandhu GS. Outcome of endoscopic treatment of adult postintubation tracheal stenosis. Laryngoscope 2007;117:1073–1079. doi: 10.1097/MLG.0b013e318050ca12.
4. Qiu XJ, Zhang J, Wang J, Wang YL, Xu M. Application of paclitaxel as adjuvant treatment for benign cicatrical airway stenosis. J Huazhong Univ Sci Technolog Med Sci 2016;36:817–822. doi: 10.1007/s11596-016-1668-6.

How to cite this article: Chen F, Zhang J, Qiu X, Wang T, Pei Y. Efficacy and outcomes of endoscopic management of post-tracheostomy tracheal stenosis: a retrospective study from an interventional center in China. Chin Med J 2022;135:851–853. doi: 10.1097/CM9.0000000000001634