International Journal of Otorhinolaryngology and Head and Neck Surgery
Chopra M et al. Int J Otorhinolaryngol Head Neck Surg. 2026 Apr;12(2):245-249
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937
DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20260730

Case Series

Flexible bronchoscopic management of high post-intubation tracheal stenosis: a case series

Manu Chopra*, Saikat Sarkar, Rahul Tyagi, Kishore Kislay, Srishti Tripathi, Kiran Jagtap

Department of Respiratory Medicine, Army Institute of Cardio Thoracic Sciences, AFMC, Pune, Maharashtra, India

Received: 02 December 2025
Revised: 03 February 2026
Accepted: 24 February 2026

***Correspondence:**
Dr. Manu Chopra,
E-mail: drmanuchopra@gmail.com

ABSTRACT

Post-intubation tracheal stenosis (PITS) affecting the upper 5 cm of the trachea, is difficult to manage because of its proximity to the vocal cords and the higher risks associated with surgery. Flexible bronchoscopic procedures provide a minimally invasive option for patients who are unsuitable for operative treatment. We describe a retrospective case series evaluating the outcomes of flexible bronchoscopic management in six patients with high PITS treated at a tertiary care chest centre of the Indian Armed Forces. Over a mean follow-up exceeding three years, all surviving patients remained symptom-free. This case series suggests that flexible bronchoscopic management is a safe and effective option for selected patients with high PITS and may represent a reasonable alternative when surgical treatment is not feasible.

Keywords: Post-intubation tracheal stenosis, Flexible video bronchoscope, CRE balloon, Cryotherapy, Electrocautery, Cotton-Meyer classification

INTRODUCTION

Post-intubation tracheal stenosis (PITS) is a serious and potentially life-threatening complication of prolonged endotracheal intubation or tracheostomy, resulting in progressive airway narrowing. This occurs due to ischemic injury from cuff pressure or mechanical trauma, leading to inflammation, granulation tissue formation, fibrosis, and eventual tracheal stenosis. The global incidence of PITS ranges from 10% to 22% following prolonged intubation, but only 1-2% of cases develop severe stenosis that presents with inspiratory Stridor and requires definitive intervention.[1-4] In India, tertiary care centres have reported a significant burden of PITS, highlighting the need for early recognition and effective management strategies.

High PITS, defined as stenosis occurring within the upper 5 cm of the trachea, poses unique challenges due to its anatomical location and increased risks associated with surgical resection and anastomosis. This study, evaluates the efficacy of flexible bronchoscopic management as a minimally invasive alternative across six cases. Advanced bronchoscopic interventions—including electrocautery, cryoablation, laser therapy, and controlled radial expansion (CRE) balloon dilatation—were performed using a flexible video bronchoscope under conscious sedation. The outcomes using this approach were favourable and patients were found to be symptom-free on prolonged follow-up.

CASE SERIES

Case 1

A 49-year-old male with subarachnoid haemorrhage requiring prolonged mechanical ventilation developed PITS. He initially underwent laser therapy with T-tube

placement in August 2017; however, within 24 hours of T-tube removal six months later, he experienced cardiac arrest necessitating emergency tracheostomy. Subsequent airway stenting provided temporary relief, but he re-presented in July 2019 with respiratory distress. Bronchoscopy revealed a fractured and unhealthy stent that was removed with difficulty, following which residual Cotton–Meyer grade III high tracheal stenosis was identified.

Given prior interventions and surgical risk, the patient declined operative management. The patient was initially managed conservatively with Non-invasive ventilation (NIV), broad-spectrum antibiotics, and a combination of inhaled and oral steroids. He then underwent CRE balloon dilatation under conscious sedation using a flexible video bronchoscope. The procedure was initiated with a 3 mm balloon, progressively increasing up to 12 mm, with each dilation maintained for 30 seconds, followed by a recovery period of 1-2 minutes. The maximum balloon size was increased by 3 mm in each session, with procedures repeated every 72 hours until an adequate dilation of 15mm was achieved.

The patient remains under regular follow-up, initially undergoing flexible video bronchoscopic surveillance every three months for the first year. Currently, he is on six-monthly clinical and spirometric follow-ups, along with an annual CT scan of the neck and flexible video bronchoscopy, as and when needed. He has been under observation for the past five years with no recurrence of tracheal stenosis.

Table 1: Demographic, clinical and procedural details of patients.

S. no.	Age (yrs)	Sex	Indication for prolonged ventilation	Severity of stenosis (cotton - meyer grading)	Bronchoscopic strategy used	Sessions required	Outcomes
1	49	M	Sub- arachnoid hemmorhage	Grade III	CRE balloon dilatation	15	Asymptomatic on follow up
2	45	M	Severe pneumonia	Grade III	Cryotherapy and CRE balloon dilatation	12	Asymptomatic on follow up
3	39	M	Acute severe asthma	Grade III	ND YAG laser and CRE balloon dilatation	06	Asymptomatic on follow up
4	30	M	Traumatic diffuse axonal head injury	Grade III	Cryotherapy and CRE balloon dilatation	16	Patient expired
5	40	M	Severe pneumonia	Grade III	Electrocautery and CRE balloon dilatation	04	Asymptomatic on follow up
6	69	F	Severe pneumonia	Grade III	Electrocautery, cryotherapy, argon plasma coagulation (APC), and controlled radial expansion (CRE) balloon dilatation	22	Asymptomatic on follow up

Case 2

A 45-year-old male with comorbidities of obesity and bronchial asthma was initially admitted with severe pneumonia, requiring prolonged intubation and subsequent tracheostomy. After successful weaning, he was decannulated; however, within 48 hours, he developed significant inspiratory stridor and was found to be hypoxemic on room air.

Further evaluation, including CT imaging and flexible bronchoscopy, revealed high PITS located 2 cm below the vocal cords, extending over a 5 cm segment. The stenosis was classified as Cotton-Meyer grade III, with significant submucosal oedema. The patient was a difficult candidate for intubation, with a high risk of weaning failure. If left untreated, he would have required either a permanent tracheostomy or a T-tube—both of which he was unwilling to accept due to his service requirements. Given the high surgical risk and the patient's refusal of surgery, a multidisciplinary approach was adopted in collaboration with ENT surgeons and anesthesiologists. He was subjected to cryotherapy using a flexible video bronchoscope under conscious sedation. A 'freeze-thaw' technique was employed, starting with 10–20 seconds of freezing followed by passive thawing, targeting the oedematous mucosa. This was followed by CRE balloon dilatation.

The procedure was repeated every 48 hours, during which the slough from the previous session was removed, followed by repeat freeze-thaw cryotherapy to the remaining oedematous mucosa and gradual CRE balloon dilatation. The balloon diameter was progressively increased, ensuring avoidance of mucosal tears and bleeding to prevent further oedema and fibrosis. The

sessions were continued until an adequate airway diameter of 15 mm was achieved. Post-procedure, the patient was maintained on continuous positive airway pressure (CPAP) and advised lifestyle modifications for obesity. He remains asymptomatic and has been on regular follow-up.

Case 3

A 39-year-old male developed post-tracheostomy tracheal stenosis following prolonged intubation for acute severe bronchial asthma. The extended duration of intubation led to the formation of circumferential scar tissue, resulting in a stenotic segment 6 mm in diameter, located 3 cm below the vocal cords. The patient presented with progressive dyspnoea and stridor, and was found to have Cotton-Meyer grade III stenosis necessitating intervention. Management began with endobronchial laser therapy using the Nd: YAG laser, precisely targeting the fibrotic scar tissue and excessive granulation within the trachea. Mercedes-Benz incisions were made to release the stenotic ring, followed by CRE balloon dilatation to gradually widen the tracheal lumen while minimizing mucosal trauma. The procedures were performed in multiple sessions under conscious sedation to ensure optimal airway patency without excessive trauma. The patient achieved near-complete resolution of the stenosis, with significant symptomatic improvement. He has remained asymptomatic and has been on regular follow-up for the past four years.

Case 4

A 30-year-old male, bedridden due to a traumatic diffuse axonal head injury, developed post-intubation tracheal stenosis following prolonged mechanical ventilation. Despite his neurological condition, he had a strong desire to eat and speak normally. The evaluation revealed significant submucosal oedema and tracheal stenosis Cotton-Meyer grade III, starting 2 cm below the vocal cords and extending beyond the tracheostomy tube stoma. Given the patient's condition, a flexible video bronchoscopic approach was initiated. Cryotherapy using the 'freeze-thaw' technique was applied to reduce the mucosal oedema, enabling the safe removal of the tracheostomy tube. As the oedema subsided, residual stenosis was managed with sequential CRE balloon dilatation combined with intermittent cryotherapy to prevent restenosis. This stepwise approach successfully restored airway patency, allowing the soldier to breathe and speak without external support. Unfortunately, despite successful airway management, he had status epilepticus and succumbed to his illness.

Case 5

A 40-year-old male developed high tracheal stenosis following prolonged intubation for severe pneumonia and sepsis. The extended ventilatory support led to the formation of dense fibrotic scar tissue, resulting in a critical airway narrowing of 5 mm, located 2 cm below the vocal cords in the upper trachea which was classified as Cotton-Meyer grade III. Unlike other cases, the stenotic segment exhibited minimal oedema but significant fibrosis, making its management particularly challenging due to its proximity to the vocal cords. He was given the option of surgery but was unwilling for the same. Given the complex nature of the stenosis, the patient required carefully tailored intervention. A combination of electrocautery incisions and CRE balloon dilatation was employed initially. Electrocautery was utilized to precisely incise the fibrotic stenosis, facilitating mechanical dilation without excessive tissue trauma. Since mucosal oedema was absent, cryotherapy was not applied. Gradual CRE balloon dilatation was then performed under conscious sedation with flexible video bronchoscopic guidance until optimal airway patency was achieved. The patient responded well to the procedure and remains under regular follow-up with stable respiratory function.

Case 6

A 69-year-old female with a history of hypertension, coronary artery disease (CAD), and chronic obstructive pulmonary disease (COPD) was admitted with severe pneumonia. She required immediate intubation and underwent multiple reintubations over three weeks before undergoing a tracheostomy due to prolonged mechanical ventilation. Following a gradual recovery, she was successfully decannulated after four weeks. However, within two weeks of decannulation, she developed a progressive cough, resting breathlessness, and stridor, raising concerns for PITS. NCCT of the neck and chest revealed focal cervical tracheal stenosis (8–9 mm in length) along with stenosis at the origin of the bronchus intermedius, leading to complete collapse and consolidation of the right lower lobe basal segments. A flexible video bronchoscopy confirmed the presence of tracheal stenosis which was classified as Cotton-Meyer grade III. She was advised surgery but was considered a high-risk patient for surgery due to advanced age, multiple comorbidities and poor cardiorespiratory reserve. She was then taken up for flexible video bronchoscopic intervention.

Her management was complex and required 22 sessions of multimodal intervention over four months, including electrocautery, cryotherapy, argon plasma coagulation (APC), and CRE balloon dilatation. Initially, cryotherapy with the 'freeze-and-thaw' technique was employed to reduce extensive submucosal oedema, followed by gradual balloon dilatation. However, while upper tracheal stenosis improved, new fibrotic stenosis developed in the lower airway after two months. This necessitated a shift in approach, utilising electrocautery incisions and APC, followed by CRE balloon dilatation. Due to the risk of mucosal injury and restenosis, antifibrotics and low-dose steroids were added to counter excessive fibrosis and inflammation. Despite her age and the complexity of

repeated interventions, the patient responded favourably. She is currently under regular follow-up, with no residual stridor or oxygen requirement, demonstrating a successful long-term outcome.

DISCUSSION

PITS, particularly high stenosis involving the subglottic region, upper trachea, and stoma sites, remains a therapeutic challenge for ENT surgeons, interventional bronchoscopists, and cardiothoracic surgeons because of anatomical complexity and the absence of a standardized treatment pathway. A retrospective review of 392 patients over two decades reported poorer outcomes with laryngotracheal resection and tracheostomy in selected populations.[5] In our series, five of six patients were successfully managed without surgical intervention or permanent stent placement, supporting the growing role of bronchoscopic therapy in carefully selected high-risk individuals.

Tracheal stenosis is broadly categorized as simple or complex based on vertical extent and cartilage involvement. Simple lesions (<1 cm without tracheomalacia) typically respond well to endoscopic therapy, whereas complex strictures exceeding 1 cm or involving full-thickness airway injury are more difficult to manage. Lesion morphology further influences outcomes, with circumferential stenoses often requiring repeated interventions. A study of 201 PITS patients reported resolution in 96% of simple cases and 79% of complex cases treated endoscopically.[6] All patients in our cohort had complex stenosis and required multiple bronchoscopic sessions, reflecting the procedural burden typically associated with such lesions. Notably, Case 3 with circumferential post-tracheostomy stenosis required laser incision followed by balloon dilatation and achieved durable symptomatic relief. Treatment selection must consider clinical status, symptom severity, and institutional resources, particularly where surgical expertise is limited.[7] Flexible video bronchoscopy can effectively deliver multimodal therapy under conscious sedation without reliance on rigid bronchoscopy, thereby optimizing resource utilization while minimizing procedural risk. This approach proved particularly valuable in elderly patients and those with significant comorbidities, as demonstrated in Case 6, who required 22 intervention sessions yet ultimately achieved sustained airway patency.

Although surgical resection remains the definitive treatment for severe stenosis, it may be less suitable for high tracheal lesions, geriatric patients, long-segment disease, or individuals with compromised cardiopulmonary reserve. In our cohort, most patients had prolonged intubation histories, repeated airway instrumentation, or underlying comorbidities, making them suboptimal surgical candidates.

Bronchoscopic modalities such as CRE balloon dilatation, laser therapy, cryotherapy, APC, and stenting play complementary roles in airway restoration. Balloon dilatation provides immediate luminal expansion but may require repetition due to restenosis, with long-term success reported in 43% of patients at 32 months.[8] Consistent with this, several of our patients underwent staged dilatations to maintain airway calibre, particularly those with stenosis near the vocal cords. Laser resection using ND:YAG or CO_2 systems is effective for membranous stenosis, though recurrence rates between 23% and 43% have been reported.[9] Employment of laser incision in Case 3, which involved dense circumferential fibrosis, facilitated controlled mechanical dilatation and a favorable long-term outcome.

Cryotherapy, first described in 1977, achieves tissue destruction through ultra-low temperatures generated via the Joule–Thompson effect and is associated with minimal collateral injury. Flexible cryoprobes (1.1-2.4 mm) allow cost-effective deployment even in critically ill patients.[10,11] In our series, cryotherapy was particularly beneficial in oedematous lesions, enabling safe decannulation in bedridden Case 4 and improving airway diameter in high-grade stenosis adjacent to the vocal cords in Cases 1, 2, and 5. APC offers non-contact thermal coagulation with energy settings typically ranging from 30-60 watts and gas flow rates of 0.5-2.0 l/min, making it advantageous in anatomically challenging airways. ts utility became evident in Case 6, who developed secondary fibrotic narrowing during treatment and required escalation to APC combined with electrocautery.

Airway stenting is generally reserved for cases where dilatation alone is insufficient; however, complications such as migration and granulation tissue remain limiting factors. Notably, none of our surviving patients required permanent stenting, likely reflecting the effectiveness of a tailored multimodal strategy guided by the predominant pathology—oedema versus fibrosis. Surgical resection with end-to-end anastomosis continues to provide definitive management for extensive stenosis, though the reported failure rate of approximately 15% underscores the need for alternative strategies in high-risk populations.[5] Adjunctive therapies such as steroids and mitomycin C may further reduce inflammatory response and scar formation. We selectively used short-duration systemic steroids to mitigate post-procedural inflammation.

Tracheostomy remains a final option for refractory disease; however, accumulating evidence suggests that combining bronchoscopic modalities often yields superior functional outcomes. In our patients, sequential use of balloon dilatation with cryotherapy, electrocautery, or laser allowed durable airway patency while avoiding permanent airway devices.

Emerging technologies such as coblation may further refine bronchoscopic management by enabling controlled tissue ablation with reduced thermal injury. As interventional pulmonology continues to evolve, individualized, multidisciplinary treatment planning remains central to optimizing outcomes.

CONCLUSION

Flexible bronchoscopic management emerges as a safe and effective minimally invasive option for high PITS, particularly in patients unfit for surgery or unwilling to undergo invasive procedures. This case series highlights the successful use of multimodal interventions—including CRE balloon dilatation, cryotherapy, electrocautery, laser therapy, and APC—tailored to the morphology and pathology of the stenosis. Despite the anatomical complexity and high recurrence potential of high PITS, bronchoscopic therapy achieved favourable long-term outcomes, with five out of six patients remaining asymptomatic on follow-up and avoiding surgical resection or permanent stenting.

The procedures were safely performed under conscious sedation using flexible video bronchoscopy, optimizing patient comfort and resource utilization. The study highlights that with appropriate case selection and multidisciplinary coordination, flexible bronchoscopy under conscious sedation can deliver safe, cost-effective, and repeatable treatment, significantly improving quality of life. These findings support the growing role of interventional pulmonologists in managing PITS, especially in resource-constrained or high-risk surgical settings, and call for wider adoption of structured bronchoscopic protocols.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Pearson FG, Andrews MJ. Detection and management of tracheal stenosis following cuffed tube tracheostomy. Ann Thorac Surg. 1971;12(4):359-74.
2. Grillo HC, Donahue DM, Mathisen DJ, Wain JC, Wright CD. Postintubation tracheal stenosis. Treatment and results. J Thorac Cardiovasc Surg. 1995;109(3):486-92.
3. Stauffer JL, Olson DE, Petty TL. Complications and consequences of endotracheal intubation and tracheotomy. A prospective study of 150 critically ill adult patients. Am J Med. 1981;70(1):65-76.
4. De S, De S. Post intubation tracheal stenosis. Indian J Crit Care Med. 2008;12(4):194-7.
5. Wright CD, Li S, Geller AD, Lanuti M, Gaissert HA, Muniappan A, et al. Postintubation Tracheal Stenosis: Management and Results 1993 to 2017. Ann Thorac Surg. 2019;108(5):1471-7.
6. Ravikumar N, Ho E, Wagh A, Murgu S. The role of bronchoscopy in the multidisciplinary approach to benign tracheal stenosis. J Thorac Dis. 2023;15(7):3998-4015.
7. Gulilat D, Genetu A, Kejela S, Kassa S, Bekele A, Tizazu A. Nonmalignant tracheal stenosis: presentation, management and outcome in limited resources setting. J Cardiothorac Surg. 2024;19(1):21.
8. Lee KH, Ko GY, Song HY, Shim TS, Kim WS. Benign tracheobronchial stenoses: long-term clinical experience with balloon dilation. J Vasc Interv Radiol. 2002;13(9):909-14.
9. Mehta AC, Lee FY, Cordasco EM, Kirby T, Eliachar I, De Boer G. Concentric tracheal and subglottic stenosis. Management using the Nd-YAG laser for mucosal sparing followed by gentle dilatation. Chest. 1993;104(3):673-7.
10. Ojard MM, Yarrarapu SNS, Guru PK, Tucker LKN, Sanghavi DK. Bronchoscopy-guided Cryotherapy for Airway Obstruction from Bronchial Cast. J Community Hosp Intern Med Perspect. 2024;14(1):93-4.
11. Jung YR, Taek Jeong J, Kyu Lee M, Kim SH, Joong Yong S, Jeong Lee S, et al. Recurred Post-intubation Tracheal Stenosis Treated with Bronchoscopic Cryotherapy. Intern Med. 2016;55(22):3331-5.

Cite this article as: Chopra M, Sarkar S, Tyagi R, Kislay K, Tripathi S, Jagtap K. Flexible bronchoscopic management of high post-intubation tracheal stenosis: a case series. Int J Otorhinolaryngol Head Neck Surg 2026;12:245-9.