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Surgical Management of Post-Intubation Tracheal Injuries: A Single-Center Experience from Nepal

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ABSTRACT

Introduction

Despite various improvements in technology and patient care, tracheal intubation and tracheostomy still result in significant tracheal injuries like stenosis and airway fistula. Pressure necrosis by the inflated balloon is the commonest culprit. Post-intubation tracheal stenosis is a major indication for tracheal resection and anastomosis. This study was done to find out the indications and results of surgery for post-intubation tracheal lesions.

Methods

It was a descriptive observational study of patients with post-intubation tracheal lesions managed in Manmohan Cardiothoracic Vascular and Transplant Center over a period of 20 years (2001 to 2021).

Results

Twenty five patients were treated for post-intubation tracheal lesions. Four had isolated tracheo-esophageal fistula (TEF); eighteen had an isolated tracheal stenosis and three had both. Most had a tracheal resection and end-end anastomosis (REEA) via a cervical approach, resecting an average of 2.7 cm of tracheal length. The average size of stenotic lumen was 4.32 mm. There were no operative deaths. Two patients expired within a month of surgery: one due to fatal restenosis and the other due to sepsis. There were a few immediate and a few long-term complications. The average follow-up period was 5 years.

Conclusion

Among the various post-intubation lesions, tracheal stenosis is the commonest indications for surgery. The management is challenging but safe and feasible, with a multidisciplinary team approach.

Keywords
Endotracheal intubation, resection and anastomosis, tracheal stenosis, tracheostomy, tracheo-esophageal fistula

INTRODUCTION

Iatrogenic injuries to trachea e.g. after endotracheal intubation and tracheostomy continue to pose serious challenges to surgeons. The cuffs and tips of the tubes can cause pressure necrosis of the mucosa. Moreover, the tracheostomy tubes can injure the trachea at the stoma. In both these situations, complications like postintubation tracheal stenosis (PITS), tracheo-esophageal fistula (TEF), granulation or bleeding can occur.[1]

PITS remains the most common indication for tracheal resection and reconstruction.[2] Simple, cartilage sparing, subcentimeter tracheal stenoses may be managed with endobronchial methods, but for most others and for TEF, surgery remains the most definitive treatment.[3] The purpose of this study is to find out the indications and results of surgery in such patients at our center.

METHODS

This is a descriptive observational study conducted in the Department of Cardiothoracic and Vascular Surgery, Manmohan Cardiothoracic Vascular and Transplant Center, Tribhuvan University. The study included all the patients who were managed in the department for various post-intubation tracheal lesions, from September 2001 to September 2021. Patient consents were not obtained because of the retrospective nature of the study. There were no exclusion criteria. From the inpatient records, detailed information was obtained on demographics, mode of tracheal injury, diagnostic methods, indications, treatment details, outcomes and follow-up. Microsoft excel 2021 was used to derive frequencies and measures of central tendency and dispersion from the data.

RESULTS

A total of 25 patients required thoracic surgical care for tracheal pathologies stemming from tracheal intubation with an endotracheal or tracheostomy tube. (Table 1) The sex ratio was 0.32. Nineteen of the patients (76%) were 30 years or younger. The reasons for hospitalization were varied, with the most common being poisoning (8/25; 32%). Eighteen (72%) patients had isolated PITS. Almost all (23/25; 92%) resulted as a sequel of endotracheal intubation. Over the years, the average duration of intubation came down from 19 days and plateaued at just below 2 weeks, with the shortest intubation time of mere 3 days noted in a 9 year-young girl. All patients were symptomatic at presentation, with dyspnea, stridor and cough the commonest in those having PITS. Patients with TEF were noted to have a sudden cough after every feed. Twenty out of 25 patients went straight to tracheal reconstructive surgery; five had one of rigid dilatation, T-tube or tracheostomy beforehand. All the TEF (7/7) patients and 16/18 isolated PITS patients involved the cervical trachea. None of the patients had a preoperative vocal cord paralysis or tracheomalacia.

The commonest procedure was a resection and end-to-end anastomosis (REEA), in 20 patients. In patients with isolated TEF, the fistula was taken down, tracheal defect repaired in a single layer and esophageal repair done in 2 layers; followed by a local muscle flap sandwich and a feeding jejunostomy (FJ). Most (21/25; 84%) patients were approached via cervicotomy. (Table 2) Anterior and partial posterior tracheal release was performed in all undergoing REEA, augmented by Montgomery suprahyoid release in the neck and hilar release in the chest. Majority (14/20) of the suprahyoid release was done via a separate incision over the hyoid bone; in others the main surgical incision was utilized for the purpose.

Twenty four patients were anesthetized using tracheal intubation of some sort. In 19 of them, anesthesia was begun by intubating the patient so that the tip of the tube stayed proximal to the proximal end of the stenosis. In those undergoing REEA, after the subsequent dissection, trachea was

Table 1. Clinical profile of patients

Characteristics	Number (%)
Gender	
Male	6 (24)
Female	19 (76)
Age in years	
Mean	29±12.58
Range	9-66
Antecedent problem	
Poisoning	8 (32)
Trauma/Stroke	7 (28)
Pneumonia/Sepsis	7 (28)
Others	3 (12)
Cause of tracheal injury	
Endotracheal tube	23 (92)
Tracheostomy tube	2 (8)
Diagnosis	
Tracheal stenosis	18 (72)
Tracheal stenosis with tracheo-esophageal fistula	3 (12)
Tracheo-esophageal fistula	4 (16)
Duration of intubation in days	
Mean	14±0.71
Range	3-30
History of prior interventions	5 (20)
Rigid bronchoscopy & T-tube	3
Tracheostomy	2

Table 2. Treatment Details

Characteristics	Number (%)
Location of tracheal pathology	
Cervical	23 (92)
Mediastinal	2 (8)
Surgical approach	
Cervicotomy	21 (84)
Cervicotomy + partial sternotomy	1 (4)
Right Thoracotomy	2 (8)
Bronchoscopic	1 (4)
Procedure	
REEA ± TEF Repair	20 (80)
TEF repair + FJ	3 (12)
Tracheal stenting	1 (4)
Tracheal repair, Esophageal diversion and FJ	1 (4)
Tracheal length resected, cm	
Range	1-3.5
Mean	2.7±0.92
Diameter at the stenosis, mm	
Range	2-6
Mean	4.32±1.41
Anesthesia strategy	
General anesthesia + proximal intubation	19
Via Tracheostomy	5
Fem-Fem CPB	1
On-table extubation	
First 10 years	2 (16.6)
Second 10 years	8 (61.6)

incised at the junction of stenosed segment and the distal healthy part, and cross-field ventilation established with a flexometallic tube. In four patients, the pre-existing tracheostomy tube was utilized to begin anesthesia. In one patient (9/F), femoro-femoral cardiopulmonary bypass (CPB) was established under local anesthesia and sedation, followed by intravenous induction. In another patient (38/F), surgery begun under local anesthesia was later continued with cross-field intubation.

After excision of the stenosed segment (Table 2), the trachea was mobilized further. Interrupted absorbable sutures were used to complete the posterior anastomosis first, with subsequent advancement of the endotracheal tube distally, followed by completion of the anterior anastomosis. The purpose was to achieve a tension-free anastomosis, which was subsequently checked for air-tightness under a positive airway pressure not exceeding 25 cm H2O. None of our patients received a 'protective' tracheostomy at the end of surgery. The neck, extended during the initial phase of surgery, was flexed after tracheal mobilization.

Table 3. Complications after REEA

Complications	Outcome	Number (%)
Restenosis	Death	1
	Dilated with success	2
	Re-REEA	1
Dehiscence	T-tube	2
	Total	6 (24)

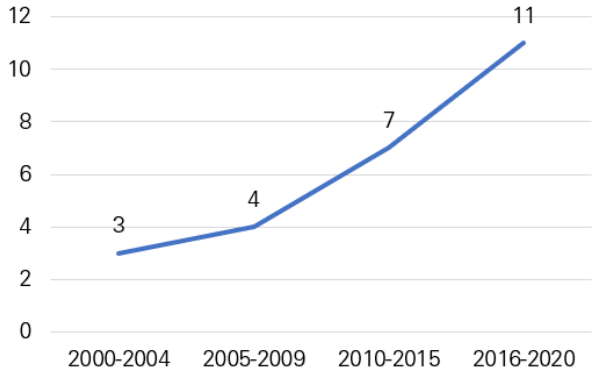

Figure 1. Trend of patient number over the years

Guardian stitches (submental crease to presternal skin) were in place for 5 days. Ten patients were extubated on table and 13 extubated within the first 24 hours. One of the patients was never extubated: she got a tracheostomy on day 5 and expired on day 7, of sepsis. One patient got extubated on day 5.

There was no operative mortality. Three patients (12%) had at least one immediate postoperative complication (anastomotic bleed, reintubation, pneumothorax), but none had recurrent laryngeal nerve (RLN) injury. Average ICU stay was 4.9±1.9 days (range: 3-15). Mean hospital stay was 10.7±2.6 days (range: 6-25). Six patients (24%) had long-term complications. (Table 3) The patient who had a tracheal stenting for her TEF got a tracheostomy on day 5 and succumbed to sepsis on day 7. Another patient had a fatal tracheal restenosis on day 21.

The 23 survivors were doing well for a mean follow-up period of 5 years (range: 1-10 years).

DISCUSSION

Tracheal intubation, a life-saving procedure, is frequently done to protect airways and to provide mechanical ventilation in appropriate patients. Post-intubation lesions of trachea are well-known. The commonest are stenosis, granulation, ulcers, fibrinous obstructive lesions, TEF, tracheomalacia and tracheo-arterial fistula.[4] TEF occurs in less than 1% of intubated patients, in general, and may be isolated or be coexistent with PITS, as in our series.[4] An ischemic necrosis of the posterior tracheal and

anterior esophageal walls may ensue as early as 10 hours, especially with cuff pressures exceeding 25 mmHg. Frequent tube manipulations, concurrent use of nasogastric tube, prolonged intubation, diabetes and use of steroids, are other risk factors.[4]

PITS is essentially a sequel of fibroproliferative response to pressure injury, and is best prevented.[2, 5] Indeed, the use of large-volume, low-pressure cuffs (in place of the high pressure, low-volume cuffs used earlier) and improvement in patient care have reduced the occurrence to a large extent, but the figures are still alarming. The reported incidences of tracheal stenosis following endotracheal intubation and tracheostomy are 6%-21% and 0.6%-21%, respectively.[1, 2, 6] Some new estimates place the incidence at 2%-3%.[3] Apparently, the numbers have steadily increased over the years in our center, although it may also reflect an increasing awareness of the problem and changing referral patterns rather than just a rising incidence. (Fig 1) Elsewhere, an increasing numbers of intensive care units, increasing number of intubations and tracheostomies, and expanding indications for mechanical ventilation may be responsible for rising incidences of PITS and TEF.[3] Although it is logical to assume that a longer duration of intubation has more deleterious effect on the trachea, studies have shown that the incidence of PITS does not necessarily correlate with this.[6] Intubation for as little as 3 days has resulted in PITS in one of our patients, but this is by far not the shortest recorded. In one of Grillo's series, two patients had been intubated for less than 18 hours and several for less than 48 hours.[2] Our patients were intubated for an average of 14 days, but breaking down the duration of the study into four successive quarters, the duration of intubation has come down from an average of 19 days and plateaued at just below 2 weeks. The manifestation of stenosis may also be delayed by several weeks after the discontinuation of intubation, as different patients have different rates of progression, and as the symptoms are not appreciated until when 2/3rd of the lumen is compromised.[5] However, most of these stenoses become diagnosed within 3 months of extubation. Regardless of this lag, the basic pathophysiology revolves around the progression from excessive cuff pressure (>25-30 mmHg) to mucosal injury to chondritis to cicatrial fibrosis to stenosis.

PITS increases work of breathing and reduces the peak flow rate. TEF compromises nutrition, and causes recurrent chest infections. Thus, a timely diagnosis and early treatment of these conditions are essential to preserve function and save lives. Various conservative measures like repeated dilatation, laser and stents are used in selected cases, but the success rates are not very encouraging. For example, failure rates for laser treatment are as high as 23%-43%.[2] Generally, those shorter than 1 cm and wider than 5 mm, with no loss of cartilaginous support and no circumferential scarring are selected for conservative measures.7 So far, no randomized trials have directly compared conservative and operative management. In the current series, three patients were managed initially with repeated dilatation, only to require surgery ultimately. The majority (20/25) were taken up straight for surgery. REEA remains the proven, time-honored and definitive approach to PITS, 'requiring no commentary' with success rates reaching as high as 97% in some.[1, 2] In a large series of 521 tracheal resections for PITS, Grillo et al could achieve a 93.7% success rate.[2] The patient who received stenting for TEF in the current series was deemed unfit for the resectional surgery in view of her general condition. Basic foundations of tracheal surgery, viz. avoidance of excessive anastomotic tension, maintenance of tracheal blood supply and meticulous dissection and anastomosis, are the keys to success after operative management.[1, 3] Our surgical principles followed those of Grillo: not to 'look for' the recurrent laryngeal nerves, staying close to trachea and avoidance of lateral dissection.[8]

With meticulous surgery in high volume centers, it has been possible to resect half of the trachea.[2] We were able to resect an average of 2.7 cm of trachea, the longest segment being 3.5 cm. The use of Guardian stitch has been a traditional norm after tracheal resection, as in all our patients undergoing REEA. Few sinister complications like paraplegia attributable to hyperflexion of the neck have been reported in the postoperative period.[3] With the use of Guardian stitch to 'avoid extension rather than to induce flexion of the neck', no such complications were noted in the current series.

Proximal intubation followed by cross-field ventilation is the most commonly applied technique of anesthesia, as in 19 of our 25 patients. Although most authors do not feel the necessity of using cardiopulmonary bypass, we successfully used this technique in a patient without any attendant harms.

Complications are not uncommon after tracheal reconstruction.[9] They include granulation formation, stenosis, separation, air leak, hemorrhage, RLN injury, TEF, wound infections and laryngeal edema, among others.[2, 10] Anastomotic complications have been shown to increase mortality up to 13-fold, although this was not the case in our series.[11] Historically, use of polyglactin has significantly reduced the incidence of granulation. One of our patients had granulation formation at the suture line, and was managed with bronchoscopic debridement with no recurrence during follow-up. One of the patients died as a result of severe restenosis after 3 weeks of surgery. Two other restenoses were managed with repeated dilatations, and another required a re-REEA after failed attempts of dilatations.

Two others (20/F and 38/F) are on T-tube for the last 8 years and 10 years respectively, after initial dehiscence after REEA. In a series by Gaissert, 86 out of 137 patients who were managed with T-tubes were initially operated for PITS. One study analyzed the risk factors for anastomotic complications, and showed that diabetes, reoperation, resection >4cm, laryngotracheal resection, age <17 years and need for preoperative tracheostomy were important negative prognostic factors.[9, 12] The patient who had a fatal restenosis had a tracheostomy done 5 days before surgery. None other harbored any of the risk factors outlined. The presence of preoperative tracheostomy has been touted as a risk factor for wound infection.[3] Interestingly, none of our patients developed wound infection in the postoperative period.

Few trends are worth-noting in our series. The number of patients operated for post-intubation tracheal lesions are increasing, as shown in Fig 1. Whether this reflects an actual rise in incidence or just the increasing referrals is difficult to discern. Five of the six complications occurred in the first half of our patients, with only one occurring in the latter half; and none of the patients operated on in the last 5 years of the study had any complication so far. The on-table extubation rate has increased from 2/12 (16.6%) in the first half to 8/13 (61.6%) in the second half of our patients; and this fact might have had a role in decreasing complications. On one hand, the numbers are increasing, and on the other, the complications are decreasing presumably due to improving multidisciplinary teamwork of surgical, anesthetic and critical-care teams. In fact, it has been asserted earlier that the care of such complex problem needs to be concentrated in centers with experienced multidisciplinary teams, for optimal results.[12]

One of the obvious limitations of this study is its small size, but it does reflect the paucity of such procedures being performed. The inherent shortcomings of a retrospective study prevailed: data was limited to the inpatient records, long-term follow up records of all the patients were not available, and other factors potentially confounding the outcome could not be evaluated. Nevertheless, the study is expected to be of significance to all who are involved in the surgical treatment of post-intubation tracheal lesions. It is felt that the need of the hour is to be able to offer such treatment to all who need it, expand the indications and address diverse tracheal lesions and locations.

CONCLUSION

Of the post-intubation tracheal injuries, PITS is the commonest. Tracheal resection and anastomosis for PITS, and repair of TEF can be safely done with good outcome by applying basic principles of tracheal surgery and with optimum postoperative care.

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CONFLICT OF INTEREST

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REFERENCES

1. Sarper A, Ayten A, Eser I, et al. Review of post-tracheostomy and postintubation tracheal stenosis with special regard to etiology and treatment. Int J Thorac Cardiovasc Surg 2003;6.ISSN: 1524-0274.
2. Grillo HC, Donahue DM, Mathisen DJ, et al. Postintubation tracheal stenosis: treatment and results. J Thorac Cardiovasc Surg 1995;109: 486-93.
3. Kumar A, Asaf BB, Puri HV, et al. Resection and anastomosis for benign tracheal stenosis: single institution experience of 18 cases. Lung India 2017; 34:420-6.
4. Tauman AA, Stratakos GK. Long-term complications of tracheal intubation. In: Erbay RH, ed. Tracheal Intubation [Internet]. London: IntechOpen; 2018 [cited 2023 Jan 03]. 136 p. Available from: https://www.intechopen.com/books/6495 doi: 10.5772/intechopen.70975
5. Lee SY, Lee SM, Park SR, et al. Successful treatment of tracheal stenosis with slide tracheoplasty after the failure of resection with end-to-end anastomosis. Clin Exp Otorhinolaryngol 2009;2(4):211-14.
6. Siciliani A, Rendina EA, Ibrahim M. State of the art in tracheal surgery: a brief literature review. Multidiscip Respir Med 2018;13:34.
7. Sharpe DA, Dixon K, Moghissi K. Endoscopic laser treatment for tracheal obstruction. Eur J Cardiothorac Surg 1996;10:722-26.
8. Mostafa A, Abdelfattah N. Tracheal resection and anastomosis for benign tracheal stricture: a seven-year experience in a single tertiary institute. J Egypt Soc Cardio-Thorac Surg 2017;25:278-84.
9. Wright CD, Grillo HC, Wain JC, et al. Anastomotic complications after tracheal resection: Prognostic factors and management. Thorac Cardiovasc Surg 2004;128:731-9
10. Gaissert HA, Grillo HC, Mathisen DJ, et al. Temporary and permanent restoration of airway continuity with the tracheal T-tube. J Thorac Cardiovasc Surg 1994;107:600-6.
11. Auchincloss HG, Wright CD. Complications after tracheal resection and reconstruction. J Thorac Dis 2016;8(Suppl 2):S160-7.
12. Marchant F, Makitie A, Salo J, et al. Tracheal and laryngotracheal resections and reconstructions: a single-center experience. J Thorac Dis 2022;14(6):2053-60.