Tracheal Stenosis: Our Experience at a Tertiary Care Centre in India with Special Regard to Cause and Management

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Abstract Tracheal stenosis (TS), a challenging problem, is a known complication of prolonged intubation and tracheostomy. The management involves a multidisciplinary approach with multiple complex procedures. In this study we discuss our experience with severe TS with regards to patient characteristics, cause and management. A retrospective analysis of 20 patients of severe TS treated at a tertiary care centre was evaluated. Inclusion criteria were all patients with severe TS who required surgical intervention. Exclusion criteria were patients with associated laryngeal stenosis and TS due to cancer. Demographic data was recorded and findings relating to aetiology, characteristics of stenosis and the various aspects of therapeutic procedures performed are discussed with review of literature. Descriptive analysis of data were performed SPSS 18. Results of the 20 patients, 17 patients (85 %) developed TS post tracheostomy, or post intubation and subsequent tracheostomy. 13 Patients (65 %) had true stenosis of which 7 patients (35 %) had simple web or circumferential fibrosis and 6 patients (30 %) had complex stenosis. Seven patients (35 %) had granulations causing severe TS which were mostly suprastomal (5 patients), stomal (5 patients) and combined stomal and suprastomal (3 patients). The average length of stenosis was 3.57 cm (0.5–8 cm). Montgomery tube insertion was a common procedure in 18 patients (90 %) pre or post intervention. Each patient underwent an average of 3.4 procedures during their course of treatment which included rigid bronchoscopy and mechanical debulking, Nd YAG laser, KTP laser, balloon dilatation and

use of stents. Among the 7 patients with granulations 100 % successful decanulation was noted with endoscopic management whereas in 13 patients with true stenosis, 10 patients (76.9 %) required open surgical management (8 tracheal resection and anastomosis and 2 tracheoplasty) with 80 % successful decanulation, 2 patients (15.4 %) were treated with endoscopy with 100 % successful decanulation and 1 patient (7.7 %) was a non surgical candidate on stent. Of the total 20 patients with severe TS in this series, 17 (85 %) of patients who were decanulated, asymptomatic on routine daily activities with normal FFB were considered cured. TS is a challenging condition requiring a highly skilled multidisciplinary team for adequate management. Prolonged intubation and tracheostomy are the common causes leading to tracheal stenosis. Simple tracheal stenosis is easier to manage than a complex stenosis which usually requires an open surgical procedure for successful management. Presence of conditions like tracheoesophageal fistula and long segment tracheomalacia are poor factors for successful management. In our cases successful decanulation was possible in 85 % of the patients following a systematic multidisciplinary approach.

Keywords Tracheal stenosis · KTP laser · Tracheal resection and anastomosis · Tracheomalacia · Post intubation · Post tracheostomy · t tube

Introduction

An altered inflammatory response to injury and subsequent excessive circumferential scar formation can lead to life threatening complications to airway which may necessitate major surgical intervention. Tracheal stenosis (TS) is a complex and difficult condition to manage caused by an

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inflammatory complication of prolonged intubation or tracheostomy requiring multidisciplinary approach and well trained personnel. In this study we discuss our experience with severe TS with regards to patient characteristics, cause and management.

Methods

We performed a retrospective analysis of 20 patients of severe TS who were referred to our tertiary care centre for management between January 2006 and December 2011. The study was approved by the hospital ethical committee. TS were classified as granulations and 'true TS'. True TS was further divided into simple web like stenosis involving mucosa and complex stenosis involving cartilage [1]. Inclusion criteria were all patients with severe TS who required intervention. TS was considered severe if patients had dyspnoea on closure of stoma, obstruction of tracheal lumen above 50 % or associated with other conditions like trachea oesophageal fistula and tracheomalacia. Exclusion criteria were patients with associated laryngeal stenosis and TS due to cancer. Demographic data was recorded and findings relating to aetiology, characteristics of stenosis and the various aspects of therapeutic procedures performed are discussed with review of literature. Descriptive analysis of data were performed SPSS 18.

Results

During the study period 20 patients with clinical history, radiological or endoscopic evidence of severe TS were identified from the case records who underwent surgical intervention at our centre. Among 20 patients; there were 17 males and 3 females of the age group 6–39 years (mean 27.45 years).

Of the 20 patients, 16 (80 %) were initially intubated and 4 patients (20 %) were directly tracheotomised. All 16 patients who were initially intubated were later tracheotomised due to either requirement of prolonged ventilation, difficulty in decanulation or associated co morbidities. The patients were intubated for a period of 7–14 days (mean 8.75 days). 18 Patients required mechanical ventilation for a period of 7–36 days (mean 15.8 days).

17 patients (85 %) developed TS post tracheostomy (PT) or post intubation (PI) and subsequent tracheostomy. The patients were 9 cases of head injury and polytrauma, 2 cases of CNS disorders, 2 cases post neurosurgery for tumours and 4 cases of poisoning (organophosphorous and carbon monoxide). 3 (15 %) were due to direct external injury to the neck and trachea (tusk injury, road traffic accident, mine blast).

Fig. 1 Fibreoptic laryngoscopic view of circumferential tracheal stenosis

Of the 20 patients, 13 patients (65 %) had true stenosis of which 7 patients (35 %) had simple web or circumferential fibrosis and 6 patients (30 %) had complex stenosis (Figs. 1, 2). 7 Patients (35 %) had granulations causing severe TS which were mostly suprastomal (5 patients), stomal (5 patients) and combined stomal and suprastomal (3 patients). The average length of stenosis was 3.57 cm (0.5–8 cm). Among the various tracheal rings involved, 3rd ring (14 patients, 70 %) and 2nd ring (11 patients, 55 %) were commonest, followed by 1st ring (3 patients, 15 %), 4th ring (2 patients, 10 %) and 5th ring (1 patient, 5 %).

The patients were evaluated by flexible fibreoptic bronchoscopy (FFB) and in indicated cases where patients had related injuries by radiological evaluation by CT scan. The mean number of times FFB was performed was 5.45 (range 1–11). Montgomery t tube insertion was a common procedure in majority of patients either pre or during post intervention follow-up before successful decanulation (Fig. 3). 18 Patients (90 %) required t tube insertion pre or post intervention. 15 Patients needed before intervention for a period of 2 months to 16 months (mean 4.8 months) and 10 patients required post intervention for a period of 3–47 months (mean 11.2 months). Of the patients on t tube, successful decanulation was done in 15 patients (83.4 %); 3 patients (16.6 %) could not be decanulated; which included 2 patients with associated tracheomalacia with tracheoesophageal fistula which was repaired and 1 patient of long segment tracheal involvement following organophosphorous poisoning and subsequent metallic stent.

The various treatment options are described in Table 1. Each patient underwent an average of 3.4 procedures during their course of treatment. They included rigid

Fig. 2 CT scan revealing circumferential complex tracheal stenosis

bronchoscopy and mechanical debulking, ND YAG laser, KTP laser (Fig. 4), balloon dilatation and use of stents (Fig. 5). Among 7 patients with granulations 100 % successful decanulation was noted with endoscopic management whereas in 13 patients with true stenosis, 10 patients (76.9 %) required open surgical management (8 tracheal resection and anastomosis and 2 tracheoplasty) with 80 % successful decanulation (Figs. 6, 7), 2 patients (15.4 %) were treated with endoscopy with 100 % successful decanulation and 1 patient (7.7 %) was a non surgical candidate on stent. In our series Mitomycin C was applied locally during each intervention to prevent fibrosis and subsequent restenosis.

Of the total 20 patients with severe TS in this series, 17 (85 %) of patients who were decanulated, asymptomatic on routine daily activities with normal FFB were considered cured.

Fig. 3 Reformatted CT scan showing T tube placed in a case of tracheal stenosis

Discussion

Tracheal stenosis is an abnormal narrowing of the tracheal lumen which can affect adequate airflow and necessitate major surgical intervention. They are rarely congenital or due to external injury but are commonly caused by an inflammatory complication of prolonged intubation or tracheostomy.

MacEwen in 1880 first described PI TS as an entity. TS is the commonest late complication of prolonged intubation and tracheostomy with 10–22 % develop PI and PT stenosis [2]. Only 1–2 % finally develop symptomatic and severe stenosis needing intervention [3]. The stenotic process begins with trauma and ulceration of tracheal mucosa with superimposed local infection leading to perichondritis of tracheal cartilage followed by increased fibroblastic activity leading to circumferential scarring and airway obstruction.

The site and mechanism of stenosis depends on whether the patient has had tracheostomy or only endotracheal intubation. The cuff site of endotracheal tube is the commonest site after prolonged intubation [2, 4] whereas granulation formation at the stomal, suprastomal region, site of cuff and the tip of the tracheostomy tube are the areas of post PT stenosis.

PI stenosis is generally longer and uniform compared to PT stenosis which are generally extension of granulation tissue from injured anterior wall of trachea. In a study by Zias et al. [5] the length of stenotic segment was 2.6 versus 1.2 cm in PT stenosis. In our study the average stenotic length was 3.57 cm which included patients of TS due to external trauma and poisoning involving long tracheal segments.

In initial stages patients with TS present with subtle symptoms like increased cough and difficulty in clearing secretions till the lumen is compromised above 50 % after which the patient will have symptoms of increasing dyspnoea and later stridor [6]. TS may also present early with

Table 1 Various procedures performed for treatment of tracheal stenosis

Procedure	No of patients	No of procedures
Open surgical	10	10
ND YAG laser	1	2
KTP laser	11	39 (2–8, mean = 3.5)
Rigid bronchoscopy and mechanical debulking	8	13 (1–3, mean = 1.6)
Balloon dilatation	2	2
Stent	2 (1 mettalic mesh, 1 nitinol)	2

Fig. 4 Fibreoptic laryngoscopic view of KTP laser probe for fulgarisation of granulation

the patient being unable to be weaned off the ventilator or decanulated from the tracheostomy tube or with progressively worsening dyspnoea beginning 6 weeks to 2 months from apparent successful extubation or decanulation [7].

Evaluation of TS includes fibreoptic as well as rigid laryngotracheoscopy, radiological evaluation like CT scan and MRI. Spiral CT with three dimensional reconstructions has an excellent resolution of the anatomy of the tracheal lumen as well as the outer wall. Rigid laryngotracheoscopy has the advantage of direct visual assessment with performance of diagnostic and therapeutic procedures and is classically considered as the gold standard method for intraluminal evaluation of the upper airways [8].

Various modalities like administration of steroids, use of stents, rigid bronchoscopy and dilatation, use of lasers (CO₂, ND YAG, KTP) and open surgical treatment have

Fig. 5 Plain radiograph of neck showing the t tube with presence of metallic stent in situ

been used in the management of TS. Steroids and antibiotics have been found to be effective against granulations or early mild stenosis as it helps in reduction of granulation and fibrosis. We used steroids in cases of acute upper airway oedema post trauma or surgery to be able to wean off or decannulate the patient and not as a regular treatment protocol for TS. Meticulous care of the tracheostomy stoma and antibiotics if indicated were frequently used to prevent infection, chondritis and granulations.

Use of rigid bronchoscopy and dilatation or excision with cold instruments, laser or balloon have been used for treatment of 'true web like' TS [1] with excellent results up to 100 % success [1, 9, 10] whereas 'complex' lesions showed recurrence of up to 90 % [11]. In complex TS, interventional bronchoscopy functions as an emergency intervention or bridge before definitive surgical management [7]. In this series all cases with stomal and supras-tomal granulations/stenosis were effectively decanulated after treatment with rigid bronchoscopy and excision. We decanulated cases with mild granulations after the procedure whereas large granulations and simple stenosis were put on t tube after procedure and decanulated subsequently. Few cases required more than one procedure for successful decanulation.

Use of argon plasma coagulation, electrocautery and lasers have been described with fibreoptic and rigid bronchoscopy as an effective modality in treating granulations as well as mild stenosis [9–11]. Mehta et al. [9] have described 60 % success rate in cases of short, web like band of stenosis with 1–3 sessions of ND YAG laser. Mandell and Yellon [12] used endoscopic KTP laser

Fig. 6 Fibreoptic laryngoscopic view of tracheal resection anastomotic site on third postop day

Fig. 7 Fibreoptic laryngoscopic view of well healed tracheal resection anastomotic site three month postop

excision of suprastomal granulation and collapse in paediatric patients with 83 % success with negligible risks. Laser resection may require multiple sessions due to recurrence of granulation tissue and stenosis. A few clinicians have described increase in the extent of injury as well as increase in the length of stenosis as adverse effects with laser application [11]. In this series KTP laser has been used and found it to be effective in minimal granulations and post surgical minor web and stitch granuloma formation. The findings of increased fibrosis and firmness of tissue both luminal and extraluminal was observed during

open surgical management in cases preoperatively treated with KTP laser and failed.

Metallic Stents have been usually used in cases of airway stenting for palliation of patients with malignant stenosis whereas nitinol and dumont stents are also indicated in benign disease causing airway compromise with tracheomalacia, trachea oesophageal fistula or non surgical cases [13]. In this series metallic stent was introduced in a patient with long segment severe tracheomalacia caused due to injury by organophosphorous poisoning followed by prolonged intubation and tracheostomy. The patient has not been decanulated due to ingrowth of mucosa through the mesh as well as recurrent granulation formation. The nitinol stent was inserted in a case of short segment tracheomalacia which was removed after 6 months with successful decanulation and no complications.

Various authors consider open surgical treatment involving resection of the stenotic segment with reconstruction as the treatment of choice whereas rigid bronchoscopy and other techniques like laser excision, stenting, balloon dilatation etc. as intermediary procedures [2, 11, 14, 15]. Open surgery is recommended in patients with complex stenosis, restenosis after multiple other techniques and in conjunction with associated conditions like tracheoesophageal fistula closure. Contraindications are long segment involvement (>50 %), multiple focal involvement and poor surgical candidate. 90 % success rates have been described in the literature [2, 11, 15] with 1.8–5 % mortality rate [10, 13] and 5–15 % failure rate [2, 11, 14, 15]. Complications of open surgery include vocal cord palsy, restenosis, suture granuloma formation, and infection [16, 17]. In this series, 8 patients underwent tracheal resection and anastomosis (TRA) and 2 tracheoplasty. Most of the stenosis (8 cases) involved the upper trachea with 2 cases of mid trachea with resection of 2 cm to a maximum of 8 cm. Three cases required hyoid release for adequate tensionless closure. Two patients underwent slide tracheoplasty with reconstruction with hyoid. 8 (80 %) are decanulated and on follow-up for past 2–5 years. Two patients of repaired tracheoesophageal fistula with long segment malacia are on t tube on follow-up. One patient of slide tracheoplasty developed permanent vocal cord palsy. Three patients developed mild stenosis and two patients had suture granuloma which could be managed endoscopically.

In a study by Brichet et al. multidisciplinary, protocolised approach was used to treat TS. Rigid bronchoscopy was used for diagnosis followed by dilatation or laser excision. Cases who failed these conservative techniques were then taken up for open surgery. They described the approach to be effective with endoscopic treatment in up to 90 % patients with requirement of surgery in 2 simple stenosis (8 %) and 2 complex stenosis (13 %) [7]. In our series, 10 (50 %) of patients underwent open surgical

procedure after failing initial treatment with bronchoscopy, excision and t tube insertion. A higher rate of open treatment in our series is attributed to our centre being the tertiary care referral centre where clinically difficult cases are dealt with.

Restenosis and relapses are the most common problem of any modality of treatment with recurrences within 1–3 months after procedure which may require multiple interventions [7]. The average number of interventions in our study was 3.4 which was higher than that reported in literature as all our cases were of severe TS requiring multiple interventions [9]. Use of Mitomycin C has shown to be a potent inhibitor of human fibroblasts inhibiting vigorous granulation response noted after airway injury [18]. In our series Mitomycin C was applied locally during each intervention to prevent fibrosis and subsequent restenosis.

Conclusion

Tracheal Stenosis is a challenging condition requiring a highly skilled multidisciplinary team for adequate management. Prolonged intubation and tracheostomy are the common causes leading to tracheal stenosis. Simple tracheal stenosis is easier to manage than a complex stenosis which usually requires an open surgical procedure for successful management. Presence of conditions like tracheoesophageal fistula and long segment tracheomalacia are poor factors for successful management. t tube placement is an important part of long term management of tracheal stenosis. KTP Laser is useful in granulations and simple stenosis or as an intermediate procedure before definitive surgical intervention. Topical application of Mitomycin C reduces granulation tissue formation and prevents recurrence. In our cases successful decanulation was possible in 85 % of the patients following a systematic multidisciplinary approach.

Conflict of interest None.

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