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Surgical treatment for patients with tracheal and subgllotic stenosis

Mohammad Naeimi, MD.[1], Masoud Naghibzadeh, MD.[2], Nematollah Mokhtari, MD.[3], Shervin Shiri, MD.[4], Sadegh Golparvar, MD.[5]

Department of Otolaryngology, Ghaem Medical Center, Mashhad University of Medical Science, Mashhad, Iran.

Abstract

Background: Iatrogenic airway injury after endotracheal intubation and tracheotomy remains a serious clinical problem. In this study we reviewed post-intubation and traumatic tracheal stenosis in 47 patients with a special attention to the cause, hense surgical treatment of the stenosis was performed and the results compared with the literatures.

Methods: Since February 1995 through January 2005 a total of 47 patients with tracheal stenosis and subgllotic as a result of tracheostomy or intubation in a single institution, were explored in this study and examined for the outcomes of stenosis management. There were 39 tracheal and 8 infraglottic stenosis. Our management strategy for stenosis was end-to-end anastomosis, and cartilage graft tracheoplasty.

Results: Our management strategy for treatment of tracheal stenosis with resection and end-to-end anastomosis was associated with good outcomes. Patients were treated by tracheal or partial laryngotracheal resection. The overall success rate was 93% with the complication rate of 18%. A second operation was required on 2 patients (4%).

Conclusions: Long term tracheal tubes or intubation tubes and poor quality material tubes were the most common causes of these respiratory strictures .Our current procedures of choice for tracheal stenosis is sleeve resection with end- to -end anastomosis for short- segment stenoses (up to six rings). Cartilaginous homograft was performed when the loss the cartilage limited to the anterior part of trachea. The most common late complication was the formation of the granulations at the suture line. Granulation tissues can usually be managed with Laser or bronchoscopic removal.

Keywords: Tracheoplasty, tracheal Stenosis, tracheal Anastomosis, tracheal resection

Introduction

Iatrogenic airway injury after endotracheal intubation and tracheotomy is still a serious clinical problem. Endotracheal tubes cause pressure injury to the glottis that can result in severe commissural scarring which is difficult to treat. Tracheotomy tubes can cause severe stomal stenosis in the trachea or infraglottic region. Both methods of airway intubation can result in pressure necrosis because of the tubes cuff, which is a preventable problem. The diagnosis of tracheal stenosis encompasses a broad spectrum of lesions with varying severity [1]. Long segment tracheal stenosis and recurrent tracheal stenosis can be life-threatening prob-

1. **Corresponding author,** Associate Professor of Otolaryngology, Department of Otolaryngology, Ghaem Medical Center, Mashhad University of Medical Sciences, Mashhad, Iran. Tel:+98511 8457501, Fax:+98511 8457500. Email: dr.naeimi@gmail.com
2. Professor of Otolaryngology, Department of Otolaryngology, Ghaem Medical Center, Mashhad University of Medical Sciences, Iran
3. Professor of Otolaryngology, Department of Otolaryngology, Ghaem Medical Center, Mashhad University of Medical Sciences, Iran
4. Assistant of Otolaryngology, Department of Otolaryngology, Ghaem Medical Center, Mashhad University of Medical Sciences, Iran
5. Research Associate of Otolaryngology, Ghaem Medical Center, Mashhad University of Medical Sciences, Iran.

lems [2]. Although resection and primary end-to-end anastomosis has been the initial treatment choice for shorter stenoses, but it considered to be a rather difficult treatment for long segment tracheal stenosis [3]. Severe subglottic stenosis is a difficult condition to manage and can be treated by laryngotracheal reconstruction or cricotracheal resection [4]. Management of infraglottic stenosis is difficult, particularly when a large laryngeal defect exist or when there have been previous surgical attempts at the same site [5-7]. In this study we couldn't manage subglottic & tracheal stricture by Laser in high thickness of stricture or long stricture instead we used end to end anastomosis for this kind of stricture.

Methods

Since February 1995 through January 2005, we managed 47 patients who had experienced subgllotic , and tracheal stenosis. The tracheoplasty operation was conducted, to investigate the outcomes of management in patients developing tracheal stenosis after tracheostomy or intubation. The study was reviewed and approved by the Mashhad University of Medical Sciences Research Ethics Review Board and was conducted in a single institution.All surgical proccdures were done with agreement and consent of the patients. In 26 patients, the stenosis was a complication due to hospitalization in intensive care unit. Other affected patients were referred by other hospitals. Patient consisted 41 males and 6 females, with age range of 12-64 years. 39 patients were treated with end to end anastomosis, and 8 with Cartilage Graft Tracheoplasty. Among 47 patients some had experienced the tracheal trauma without postintubation stenosis. The initial diagnostic evaluation included plain radiography, computed tomography or both, and meticulous endoscopic assessment.

All surgical procedures were performed under general anesthesia, and a rigid bronchoscope used at the time of resection. The distal airway was divided after subperichondrialy resection of the stenotic segment, and ventilation performed through a spiral tracheal tube in the distal tracheal segment. In most cases especially those with infraglottic stenosis, the pre existing stoma was used for intubation.

All patients underwent rigid bronchoscopy. If the severity of the stenosis was less than 1 cm in length and provided the lesions had neither circumferential scarring nor loss of cartilaginous support, bronchoscopic treatment was performed. Those patients, with granular tissue at the anastomotic line, were treated by laser surgery and bronchoscopic removal of the granulomata. Cryosurgery or forceps resection of the endoluminal scars followed by a local steroid injection to prevent restenosis was adequate for these patients. Patients with long and thick, moderate or severe stenosis had resection via a cervical incision, a complete resection of the stenotic lesions between proximal and distal disease-free cartilage for a healthy anastomosis. Laryngeal release was done when it was necessary. Careful mucomucosal approximation at the anastomotic site with respect to recurrent laryngeal nerve was performed using interrupted sutures with its knots tied outside the lumen.

Stents (Montgomery T- tuba) were used in some patients and placed in situ for six weeks. The tracheal allograft reconstruction was applied as a treatment for patients with long segment and recurrent tracheal stenosis. The stenosed tracheal segment was opened to widen the patient's segment. The anterior cartilage was resected with the posterior tracealis muscle or tracheal wall remained intact. A temporary silastic intraluminal was placed in the stricture's place, and absorbale suture secured the chemically preserved trachea. In this study 8 patients underwent formal partial laryngotracheal reconstruction with costal cartilage grafting [8].

The outcome was considered good, when patients had no limitation in activity, had normal airway and good voice. Outcome was deemed

satisfactory, when patients had adequate voice with dyspnea during exercise. Failure was defined by the need for reoprative or permanent tracheostomy tube. [Tabel 1]

Results

The clinical records and physical findings of all of the patients were reviewed for etiological factors, diagnostic methods, surgical therapies, and outcomes. The initial diagnostic evaluation included plain radiography, computed tomography, or both. The severity of the stenosis was classified as mild if less than 50 % of the tracheal lumen was obstructed, moderate if the obstruction was 50% to 90%, or severe if 90% or more of the lumen was obstructed. [7, 9-11]. The severity of stenosis was mild in 15 patients, moderate in 26 patients, and severe in 6 patients. The length of stenosis in 39 patients was 2-5 centimeters, and 6 patients 2-4 centimeters, and 2 patients 2-3 centimeters. 39 patients were treated by sleeve resection and end to end anastomosis (the length of stenosis was 2-5 centimeters) and 8 patients by cartilage graft tracheoplasty (the length of stenosis was 2-4 centimeters). Distribution of causes of cervical tracheal stenosis in our patients.(Tables 2&3). Our management strategy for treatment of tracheal stenosis with resection and end-to-end anastomosis was associated with good outcomes. The outcome of patients with otocartilaginous graft was perfect. Patients were treated by tracheal or partial laryngotracheal resection with the overall success rate of 93% and the complication rate of 18%. A second operation was required for 2 patients (4%).

Discussion

The postintubation tracheal stenosis mostly occurs in one segment of trachea and usually involves in less than one third of the length of airway [12,13]. Therefore, most cases can be successfully managed by resection and anastomosis [14,15]. The surgical management of subglottic stenosis has continued to advance since posterior cricoidotomy was first described by Rethi [16] in 1956. In 1972, Fearon and Cotton [17] introduced paediatric laryngotracheal reconstruction with cartilage interpositional grafting. This method has become one of the most common techniques of expanding stenotic airway segments. The therapeutic approach for management of postintubation tracheal stenosis is thoroughly discussed by Grillo, Abbasi, Pearson and others [18-22]. They have also discussed resection procedures for treatment of subglottic stenosis.

Conservative treatments may be carried out for stenosis smaller than 1 cm in length with no circumferential scarring and no loss of cartilaginous support [23].

Costal cartilagoplasty is most often used in children, but it may be used to repair large anterior wall defects after resection in adult patients with infraglottic stenoses.

Long segment tracheal stenosis and recurrent tracheal stenosis can be life threatening problems. Although resection and primary end-to-end anastomosis has been the initial treatment of choice for shorter stenoses, this treatment is considered difficult in long segment tracheal stenoses. Numerous other treatment options have been proposed for long segment tracheal stenosis, but none has been uniformly successful [11, 24]. Recurrent tracheal stenosis is a particularly challenging surgical problem due to scarring, impaired healing, infection, devascularization, and life-threatening anastomotic disruptions. Like long segment tracheal stenosis, recurrent tracheal stenosis may be treated with a variety of both nonsurgical and surgical options, each with different success rates in different subgroups of patients. Tracheal allograft reconstruction represents a therapeutic modality with encouraging short- to medium -term results for patients with complex recurrent long segment tracheal stenosis who have not responded to conventional management. Numerous techniques has been described for the treatment of long segment tracheal stenosis and re-

Outcome	Tracheal Stenosis	Infraglotic Stenosis	N0. (%)
Good	34	4	38 (80.85)
Satisfactory	4	2	6 (12.76)
Failure	1	2	3 (6.38)
Total	39	8	47

Table 1. Distribution of causes of cervical tracheal stenosis in 47 patients.

current tracheal stenosis, including endobronchial stenting, aggressive balloon dilation, pericardial patch tracheoplasty, cartilage and rib graft tracheoplasty, and recently the tracheal autograft. Nevertheless, an important subgroup of patients exists who do not respond to these conventional treatments. Despite technological improvements and more skillful patient care in intensive care units, tracheal and laryngotracheal stenoses still constitute an important group of iatrogenic squeal after intubation and tracheostomy. Tracheal Stenosis mostly occurs at the cuff of the tube. In our series, however, the percentage of cuff stenosis is lower than that reported in published series (31%).large-volume; low-pressure cuffs markedly reduce the occurrence of cuff injury. Conservative treatments may be carried out for stenoses smaller than 1 cm in length with no circumferential scarring and no loss of cartilaginous support. In our series, patients whom had mild stenosis underwent bronchoscopic treatment with good results and without complication. Tracheal resection followed by end-to-end anastomosis is now a well established technique performed under well established indications. According to literature, the success rate is 71% to 97% [11] in our series, a satisfactory result was obtained in 93% of tracheal resections and this is comparable to the literature Lesions that involve the infraglottic larynx as well as the upper trachea are much more difficult to repair surgically. Infraglottic stenoses caused by a high tracheostomy are more extensive lesions than are infraglottic stenoses due to endotracheal tubes. Costal cartilogoplasty is most often used in children [7, 8], but it may be used to repair large anterior wall defects after resection in adult patients with infraglottic stenoses, as in our patients. The complication rate is generally low for tracheal lesions. Serious sequels more often follow parial laryngotracheal resections. In our series, the overall complication rate was 18%. The most common late complication was the formation of granulations tissue at the suture line in 9 patients. Granulations can usually be managed with bronchoscopic removal.

The role of tracheal allograft reconstruction in the management of tracheal disease is not yet established. Tracheal allograft reconstruction certainly represents an important additional option for the treatment of severe long segment

Cause	Frequency
Trauma to trachea:	
a. Cervical soft tissue trauma	16
b. Tracheal cartilage damage	1
Post-intubations stricture	N/a*
a .Cardiopulmonary disorder	13
b. Neurological disorder	8
c. Metabolic disorder	3
d. Acute attacks of chronic respiratory disorder	6

*Na= Not available

Table 2. Result of intervention for Tracheal and infraglottic Stenosis

Case No	Age/Sex	Hospital stay (day)	Surgical Procedure	Post operation Bronchoscopy	Pre operation Bronchoscopy	Length of stenosis (cm)	Cause
1	43/M	**15**	End to End	-	2	4.5	Post intubation
2	27/M	**17**	End to End	1	1	2.5	Trauma
3	45/M	**13**	Cartilage Graft	-	2	2.5	Post intubation
4	24/M	**12**	End to End	-	1	3.5	Trauma
5	26/M	**15**	End to End	1	1	4	Trauma
6	40/M	**14**	End to End	1	1	3	Post intubation
7	37/M	**15**	End to End	1	-	3	Post intubation
8	12/M	**17**	Cartilage Graft	1	1	2	Trauma
9	17/M	**13**	End to End	1	1	2.5	Trauma
10	39/M	**15**	End to End	-	2	5	Post intubation
11	26/F	**20**	End to End	2	2	3	Post intubation
12	29/M	**12**	End to End	1	-	2.5	Post intubation
13	42/M	**14**	End to End	-	1	2	Post intubation
14	54/M	**13**	Cartilage Graft	1	1	2	Post intubation
15	48/M	**18**	End to End	2		4	Post intubation
16	19/M	**15**	End to End	1	1	3	Tracheal cartilage damage
17	28/F	**17**	End to End	1	1	3	Trauma
18	49/M	**13**	End to End	1	-	2/5	Post intubation
19	31/M	**14**	End to End	1	1	4	Post intubation
20	34/M	**14**	End to End	1	-	3.5	Post intubation
21	19/F	**15**	End to End	-	1	2.5	Trauma
22	21/M	**13**	End to End	-	1	2	Trauma
23	41/M	**17**	End to End	2	2	5	Post intubation
24	48/M	**12**	End to End	-	1	3.5	Post intubation
25	27/M	**16**	Cartilage Graft	1	2	2	Post intubation
26	43/M	**17**	End to End	1	1	3	Post intubation
27	24/M	**15**	End to End	-	1	2	Trauma
28	27/F	**14**	Cartilage Graft	-	-	2	Post intubation
29	38/M	**19**	End to End	1	1	4.5	Post intubation
30	19/M	**17**	End to End	1	1	3	Trauma
31	23/M	**14**	Cartilage Graft	1	-	2.5	Post intubation
32	17/M	**14**	End to End	1	-	3.5	Trauma
33	33/M	**15**	End to End	-	1	4	Post intubation
34	22/M	**18**	End to End	-	-	2.5	Post intubation
35	18/M	**15**	Cartilage Graft	-	-	2	Trauma
36	20/F	**13**	End to End	-	1	2	Post intubation
37	31/M	**17**	End to End	-	-	3.5	Post intubation
38	43/M	**15**	End to End	1	-	2.5	Post intubation
39	28/M	**1**	End to End	1	1	3	Trauma
40	21/M	**18**	End to End	1	2	4.5	Post intubation
41	35/M	**20**	End to End	2	-	5	Post intubation
42	22/M	**16**	End to End	1	1	3.5	Trauma
43	15/F	**13**	Cartilage Graft	-	1	2	Post intubation
44	29/M	**15**	End to End	1	-	3.5	Post intubation
45	50/M	**12**	End to End	-	-	3.5	Post intubation
46	18/M	**14**	End to End	1	1	4	Trauma
47	22/M	**17**	End to End	-	1	5	Post intubation

All the patients were operated in a single staged and minimum follow-up was 1 year and half.

Table 3: Demographic data of 47 patients underwent tracheoplasty

tracheal stenosis or recurrent tracheal stenosis [24]. Primary short segment stenosis is still best treated with resection and end-to-end anastomosis. For primary long segment tracheal stenosis, if nonoperative treatment fails, pericardial patch tracheoplasty, and rib cartilage tracheoplasty and tracheal autograft reconstruction are all reasonable treatment options.

The tracheal allograft has numerous advantages including adequate availability, nearly circumferential tissue for reconstruction and a carina that may be used to permit extensive re-

pair. In addition . the procedure can be repeated if required . Follow - up bronchoscopic and histologic studies have shown clear evidence of luminal epithelialization. Ciliated columnar respiratory epithelium has been shown to cover the lumen of the allograft [24].

Conclusion

Oral or nasal endotracheal tubes or tracheostomy tubes are most commonly used to deliver mechanical ventilator support in respiratory failure. Despite technological improvements and more skillful patient care in intensive care units, tracheal and laryngotracheal stenosis still constitue and important group of iatrogenic sequelae after intubation and tracheostomy.

The longer the tracheal tube remained the more chance for trachealstenotic complication. It should be insisted that the duration, the material and poor quality are among the most important causative factors in our 47 cases of laryngotracheal Stenosis. Stenosis at both cuff site and stoma managed by resection of lesion and anastomosis. To select the treatment of choice for this problem meticulous evaluation of strictures including their clinical course, bronchoscopy finding, and response to nonsurgical methods such as dilatation, laser therapy, and stenting are all useful. 47 patients with tracheal stenosis were treated by tracheoplasty. 39 patients were treated with End to End anastomosis, 8 Cartilage Graft Tracheoplasty. Our current procedures of choice for tracheal stenosis are resection with end-to-end anastomosis for short-segment stenoses and the autograft technique for long-segment stenoses.

References

1. Hoffer ME, Tom LWC, Wetmore RF. Congenital tracheal stenosis: the otolaryngologist's perspective. Arch Otolaryngol Head Neck Surg 1994; 120: 449-53.

2. Nakayama DK, Harrison MR, de Lorimier AA. Reconstructive surgery for obstructive lesions of the intrathoracic trachea in infants and small children. J Pediatr Surg, 1982;17: 854-71.

3. Grillo HC: Tracheal replacement. Ann Thorac Surg 1990;49:864-5.

4. Schick B, Weidenbecher M, Miller R, Iro H. Experience with laryngotracheal reconstruction in subglottic stenosis in a 30 years time period. Laryngorhinootologie, 2007;86(5):358-64.

5. Hebra A, Powell DD, Smith CD, Othersen HB. Balloon Tracheoplasty in children. J Pediatr Surg 1991; 26:957-61.

6. Messineo A, Forte V, Joseph T. The ballon posterior tracheal split. J Pediatr Surg 1992;8:1142-4.

7. Cunningham MJ, Eavey RD, Gus VJ. Slide Tracheoplasty for long-Segment Tracheal Stenosis. J Thorac Cardiovasc Surg 2004;124(1):98-103.

8. Naimi M, Naghibzadeh M, Mashlab H. Surgical Treatment of Acquired and Upper Cervical Tracheal Stenosis by Rib Cartilage Graft Compared with other Procedures During 1987-2000. The Iranian journal of Otorhinolaryngology 2002;29(17):19-29.

9. Backer CL, Mavrous C, Gerber ME, Holinger LD. Tracheal surgery in children in 18- year review of four techniques. Eur J Cardiothorac Surg 2001;19(6):777-84.

10. Jacobs JP, Ethott MJ, Haw MP. Pediatric tracheal homograft reconstruction. J Thorac cardiovasc Surg 1996;112:1549.

11. Sarper A. Ayten A, Obzbdak O, Demircan A. Tracheal Stenosis after Tracheostomy or Intubation. Tex Heart Inst 2005;124-9.

12. Abbasi A, Shadmehr MB, Arab M. Reoperation for tracheal and subglottic stenosis. J Med Council Islamic Repub Ira, 2000;17: 284-90.

13. Couraud L, Jougon JB, Velly JF. Surgical treatment of non-tumoral stenosis of the upper airway. Ann Thorac Surg 1995;60: 250-60.

14. Grillo HC, Donahaue DM, Mathisen DJ. Post-intubation tracheal stenosis Treatment and results. J Thorac Cardiovasc Surg 1995;109: 486-93.

15. Bisson A, Bonnette P, El Kadi B. Tracheal sleeve resection for iatrogenic stenosis (subglottic laryngeal and tracheal). J Thorac Cardiovasc Surg 1992;104: 882-7.

16. Rethi A: An operation for cicatricial stenosis of the larynx. J Laryngol Otol 1956;70: 283-93.

17. Fearon B, Cotton RT. Subglottic stenosis in infants and children: the clinical problem and experimental surgical correction. Can J Otolaryngol 1972;1: 281-9.

18. Grillo HC. The management of tracheal stenosis following assisted respiration. J Thorac Cardiovasc Surgery 1969;57: 52-71.

19. Abbasi A. Resection anastomosis surgery for post-intubation airway stenosis. In Post-intubation airway

stenosis, The principles of diagnosis and treatment, IUTLD, Tehran, 2003, pp. 228-71.

20. Pearson FG, Cooper JD, Nemels JM, Van Nostrand AWP. Primary tracheal anastomosis after resection of the cricoid cartilage with preservation of recurrent laryngeal nerves. J Thorac Cardiovasc Surg 1975;70: 806-15.

21. Grillo HC. Primary reconstruction of airway after resection of subglottic laryngeal and upper tracheal stenosis. Ann Thorac Surg 1982;33: 3-18.

22. Ward RF, Gordon M, Rabkin D, April MM. Modifications of airway reconstruction in children. Ann Otol Rhinol Laryngol 1998;107: 365-369.

23. Backer CL, Mavroudis C, Dunham ME, Holinger LD. Repair of tracheal stenosis with a free tracheal autograft. J Thorac cardiovasc Surg 1998;115:869-75.

24. Marzovk JF. Allograft replacement of the trachea. J Thorac Cardivasc Surg 1993;105: 242-6.