



PREDICTORS OF EARLY MORBIDITY IN TRACHEAL SURGERIES

Cardiology

Dr. Madhusudan Kumhari	Assistant professor, Dept of cardiothoracic surgery, Nizam's institute of medical sciences, panjagutta, Hyderabad-500082.
Dr. Amaresh Rao Mallampatti*	Additional professor, Nizam's institute of medical sciences, panjagutta, Hyderabad-500082. *Corresponding Author
Dr Ravi Kumar K	Dept of cardiothoracic surgery, Nizam's institute of medical sciences, panjagutta, Hyderabad-500082.

ABSTRACT

OBJECTIVE: To review the clinical profile, surgical outcomes and factors influencing the outcomes in patients undergoing tracheal surgery.
MATERIALS AND METHODS: Retrospective and prospective collection of data was done from Hospital records to analyse the Predictors of early morbidity in patients undergoing tracheal surgeries.
RESULTS: Out of a total of 20 patients tracheal stenosis was present in 10 (50%), tracheo-esophageal fistula in 6 (30%) and primary tracheal tumors in 4(20%). Out of the 20 patients, tracheal resection and anastomosis was done in 15 (75%), subglottic resection in 3 (15%) and supracarinal resection in 2(10%). The mortality in our study was 15% (3 patients).
CONCLUSION: The most common cause of tracheal obstruction is postintubation/tracheostomy. Subglottic resections are associated with high postoperative morbidity.

KEYWORDS

INTRODUCTION:

The advances made in the diagnostic methodologies¹ and improvements in anaesthesia, refinements in surgical techniques^{2,3,4} have resulted in a dramatic increase in the incidence of tracheal surgery. Historically, the outcomes of tracheal surgery were poor due to the lack of critical appreciation of its unique features such as structural rigidity, short length, relative lack of longitudinal elasticity, unpaired nature and poor healing and segmental blood supply. Although a better understanding of these unique features has translated to improved surgical outcomes, however tracheal surgery still remains a challenging entity. The aim of the study was to review the clinical profile, surgical outcomes and factors influencing the outcomes in patients undergoing tracheal surgery.

MATERIALS AND METHODS:

The cases for the study were selected from the those admitted in the Department of cardiothoracic surgery, NIMS Hospital, HYDERABAD during the period of 2013 to 2018 after getting approval from ethics committee of the hospital and applying the defined inclusion and exclusion criteria. Retrospective and prospective collection of data was done from admission record, department record, operation theatre and perfusion record, ICU charts, discharge records and follow-up notes. A total of 20 patients underwent tracheal surgery.

RESULTS:

Out of 20 patients who underwent tracheal surgery, 12(60%) were female, 8(40%) were male, with a mean age of 29 years at presentation. In 6 patients who had preoperative morbidities the mean age was 32.50±14.20 and in 14 patients without comorbidities mean age was 25.86 ± 12.1. This did not show any statistical significance. The gender distribution also did not show any statistical significance either. The post intubation(2)/tracheostomy(8) group of 10 patients, was the largest group in our study, in which 6 were female, 4 were male. Among the rest of the 10 patients in our group, 6(30%) presented with tracheo-esophageal fistula and 4(20%) with primary tumours of trachea. In the post intubation/tracheostomy group of 10 patients, 3 had subglottic stenosis, one had supracarinal stenosis and 6 had tracheal stenosis. In the tracheo-oesophageal fistula group of 6 (30%) patients, 2 patients were due to prolonged endotracheal intubation, 4(20%) patients presented with tracheal tumours and included squamous papilloma, carcinoid, adenoid cystic carcinoma, and squamous cell carcinoma. The comorbidities included diabetes mellitus and renal insufficiency in one patient and Crohn's disease of the oesophagus in another. One patient presented with restenosis and 1

patients was on preoperative steroids. Of the 20 patients, 17 were operated electively and 3 underwent emergency surgery. Cervical approach was used in 10 (50%) patients, trans-sternal approach in 8(40%) and right thoracotomy approach in 2(10%) patients. Among the 20 patients, 3 patients underwent subglottic resection, 2 underwent supracarinal resection, and the rest of the 15 patients underwent tracheal resection and tracheo-tracheal anastomosis. In the subglottic resection group 2 patients had crico-tracheal anastomosis and one patient had thyro-tracheal anastomosis. In most of the cases, i.e. 12(60%) patients, 2 tracheal rings were excised. In 6(30%) patients, 3 rings and in 2(10%) patients 4 rings were excised. In the 2 patients who required excision of 4 rings, tracheal release manoeuvres were employed -perihilar, pericardial release and division of inferior pulmonary ligament.

In tracheo-esophageal fistula group, esophageal defect was repaired in two layers and the tracheal defect was repaired primarily with resection and anastomosis. In 3 patients sternocleidomastoid muscle was interpositioned between tracheal and esophageal suture lines. In one patient, esophagus was bypassed with transverse colon conduit. In two patients of this group right thoracotomy approach was used. In 6(30%) patients who had critical airway obstruction, cardiopulmonary bypass was employed through right femoral vessel before approaching the trachea.

In the postoperative period, 3 patients in the tracheal resection group died and 3 patients in the subglottic resection group developed complications in the form of laryngeal edema and dysphagia which improved with conservative management. On comparing only the postoperative morbidity between the subglottic resection and tracheal resection group, statistical significance was found (p value-0.018). Overall mortality in our study was 15%(3 patients). One patient of restenosis had developed tracheo-innominate fistula after the surgery and died on the first postoperative. The second patient was a known case of Crohn's disease who underwent tracheo-esophageal fistula repair and she developed esophageal suture line dehiscence leading to mediastinitis and sepsis. The third patient was a diabetic with chronic kidney disease. This patient was operated on an emergency employing cardiopulmonary bypass. Postoperatively patient could not be weaned off the ventilator and developed ventilator associated pneumonia and died. Remaining 17 patients were free of symptoms at discharge and were doing well on follow-up.

Statistical analysis of parameters associated with morbidity in tracheal surgery.

Parameters	Morbidity present N=number of cases (Mean±SD) or (N%)	Morbidity absent (Mean±SD) or (N%)	P-value
AGE(years) Mean ±SD	N=6/20 32.50 ± 14.20	N=14/20 25.86 ± 12.18	0.301
SEX M:F (N%)	N=6/20 2:4(10%:20%)	N=14/20 6:8(30%:40%)	0.545
Rings excised (≤2 : >2)	N=6 2.33±0.516	N=14 2.57±.756	0.493
Postoperative complications (Subglottic: Tracheal)	N=3/20	N=17/20	0.018

DISCUSSION:

Nowadays, endotracheal intubation and mechanical ventilation have become an integral part of the intensive care management of seriously ill patients. One of complication that can occur after endotracheal intubation is tracheal stenosis, especially after prolonged intubation. The incidence of tracheal stenosis after prolonged intubation or tracheostomy has been said to be in the range of 6% to 21% and 0.6% to 21%, respectively⁵. Sar Nourai and his colleagues noted that the calculated incidence of post-intubation laryngo-tracheal stenosis in England was 4.6%⁶. In a review of 31 cases by Alexandra Chronou and Nikolaos Zias, the incidence of tracheal stenosis due to endotracheal intubation was 35% and due to post tracheostomy was 20% patients⁷. In our study of 20 patients with tracheal pathologies, 10(50%) patients presented with post intubation/tracheostomy stenosis. Among these 8(80%) cases were due to tracheostomy and 2(20%) were due to endotracheal intubation. In contrast to most of the studies we found tracheostomy to be the major cause and not prolonged intubation to be the most common cause of tracheal stenosis. This might be due to the fact that post tracheostomy the patients after discharge did not make serious attempts to have their tracheostomy would closed.

Tracheoesophageal fistulas can develop due to mechanical ventilation⁸, tracheal or esophageal stenting,⁹ tracheal or esophageal surgery, granulomatous mediastinal infections,¹⁰ trauma,¹¹ iatrogenic injuries¹² and caustic ingestion. Muniappan and colleagues found the most common causes of benign tracheoesophageal fistula to be post-intubation injury (47%), trauma (17%), prior laryngectomy (17%), and prior esophagectomy (11%)¹³. In a clinical series reported by Martini N and Goodner JT, the incidence of tracheoesophageal fistula was 4.9% in 1,943 patients with esophageal cancer, 0.16% in 5,714 patients with lung cancer, and 14.75% in 41 patients with tracheal cancer¹⁴. The incidence of tracheoesophageal fistula observed in post-mortem examination ranged between 0.9 to 13%¹⁵. Currently, about 0.5% to 5.0% of tracheoesophageal fistulae arise from mechanical ventilation especially in the presence of an indwelling nasogastric tube¹⁶. In our study, 6 (30%) patients had tracheoesophageal fistula, of which 2(10%) were due to intubation, 1 due to corrosive poisoning, 1 was due to trauma, 1 due to Crohn's disease and 1 was due to nasogastric tube erosion in a patient undergoing chemotherapy for lymphoma. The site of fistula in 4(20%) cases was cervical, in 2(10%) cases it was in mid-trachea.

Tracheal tumors are rare and account for only 2% of all respiratory tract tumors¹⁷ and 0.1% of all tumours¹⁸. Hermes C. Grillo, in his study of 198 patients, reported 36% squamous cell carcinomas, 40% adenoid cystic carcinomas, and the remaining 24% as other benign and malignant tumours¹⁹. In our study, 4 patients presented with tracheal tumours. Among these, one was a squamous cell carcinoma, one carcinoid tumour, one adenoid cystic carcinoma and one squamous papilloma. Loan Cordos et al., in their study of 60 patients with tracheal resection and reconstruction for different pathologies, reported 34(56%) male patients and 26(43%) females with a median age of 38 years²⁰. In our study of 20 patients, 12(60%) patients were female and 8(40%) patients were male. Depending on the site of the lesion the surgical approach may be a cervical, trans-sternal or through right thoracotomy⁷⁰⁻⁷¹. In our patients, as in other studies the cervical approach was the most common approach, employed in 10(50%) patients followed by the trans-sternal approach, employed in 8(40%) patients.

Subglottic resections are technically challenging due to close proximity to vocal cords and recurrent laryngeal nerves. Maddus²¹ et al., between 1972 and 1991, did 53 subglottic tracheal resections with primary thyro-tracheal anastomosis for benign disease with no

operative deaths²¹. Douglas J. Mathisen treated 80 patients with subglottic resection. In all patients he resected anterior cricoid plate along with the stenotic segment, leaving the posterior cricoid plate intact²². In our study, 3(15%) patients underwent subglottic resection through cervical collar incision. Out of 3(15%) patients, 2 patients underwent partial resection of anterior cricoid plate and in one patient, anterior cricoid plate was completely removed. All 3 patients developed laryngeal edema postoperatively which improved with conservative management. In our study this was the only group which developed complication and recovered and showed statistical significance compared to the tracheal resection group.

Mitchell JD and colleagues performed 143 carinal resections and they proposed that access to carina is best achieved through right posterolateral thoracotomy²³. This we found to be true in our cases as well, where we approached the supracarinal lesions through right thoracotomy in two patients. The length of trachea excised in these two cases was approximately 3-4 centimetres. In both the cases tracheal release manoeuvres were employed for tension free anastomosis. Overall, we excised approximately 2 rings of trachea in 12(60%) patients, 3 rings in 6(30%) patients, 4 rings in 2(10%) patients. The average number of tracheal rings excised was 3. Post-operatively, all patients were kept in cervical flexion position with a guardian stitch to decrease the anastomotic tension. Statistically we did not find any significance between the number of rings excised and morbidity.

Acquired tracheoesophageal fistula is a challenging clinical problem. Douglas J. Mathisen and colleagues performed 41 surgeries in 38 patients with tracheo-esophageal fistula. 34 patients among these had strap muscle interpositioned between the trachea and esophagus²⁴. In our study, 6 patients underwent surgery for tracheo-esophageal fistula. 4 patients were operated through cervical incision and sternocleidomastoid muscle was interposed between trachea and esophagus and no complications were seen.

Cardiopulmonary bypass (CPB) is an effective method to oxygenate patients during difficult tracheal surgeries with critical airway stenosis and carinal resections. Akshay Chauhan and Satish Kumar Aggarwal performed tracheal resection and reconstruction under cardiopulmonary bypass in three cases of post intubation tracheal stenosis with good results²⁴. Prachi Kar and Amaresh Rao Malempati operated a case of adenoid cystic carcinoma in supracarinal region with near total occlusion of tracheal lumen²⁵. In our study we operated 6(30%) patients using cardiopulmonary bypass through right femoral vessel cannulation and all patients except one were discharged by day 7.

The success rate mentioned in literature for crico-tracheal resection and reconstruction is more than 95%²⁶. But the complication rate is still high (15-39%)²⁷. In our study the complication rate was 15%. Tracheo-innominate fistula is very rare but catastrophic complication of tracheal surgery. Cordos I, et al. noticed tracheo-innominate fistula in 1.7% of their patients²⁸ and Wright CD, Grillo HC, et al reported an incidence was 0.25%²⁹. In our study, one patient developed tracheo-innominate fistula in the postoperative period and died due to torrential bleeding. Overall mortality in our study was 15%(3patients). One patient of Crohn's disease developed esophageal suture line dehiscence leading to mediastinitis, sepsis and death. Another patient with chronic kidney disease and post intubational stenosis developed ventilator associated pneumonia and died. The third patient developed tracheo-innominate fistula and died due to bleeding into the airway. Macchiarini et al showed a mortality rate of 2.2% in 45 patients for tracheal surgery¹⁸. Wright et al. noted a high mortality rate of 4.8% in surgeries done for tracheoesophageal fistula³². In our study, of the patient's who died 2(10%) were in the post-intubational tracheal stenosis group and one was in the tracheoesophageal fistula group.

The surgical outcomes are influenced by not only technical factors but by patient factors as well²⁹. In our study, two patients were on immunosuppressants pre operatively, one patient was diabetic with chronic kidney disease. We did subglottic resections in 3 patients with no long-term sequelae. In our study average number of tracheal rings excised was 2. There was no statistical significance between the number of rings excised and morbidity. 17 patients did not have any post-operative complications and were doing well on follow-up.

CONCLUSION:

There is female preponderance in the occurrence of tracheal lesions possibly due their small size. Post-intubational tracheal stenosis

seems to be the most common cause of tracheal obstruction in Indian population. In patients with critical airway stenosis, cardiopulmonary bypass should be considered. In patients with extended tracheal resection, tracheal release maneuvers are very essential to decrease tension on anastomosis. The preoperative morbidities should be optimized before surgery. In patients with subglottic resections, high occurrence of postoperative complications should be anticipated, especially laryngeal edema. Adhering to the basic principles of tracheal surgery are essential for improved outcomes.

REFERENCES

1. Modern imaging of the tracheo-bronchial tree *World J Radiol* 2010 July 28; 2(7): 237-248 ISSN 1949-8470.
2. Grillo HC. Surgical approaches to the trachea. *Surg Gynecol Obstet* 1969;129:347.
3. Grillo HC, Dignan EF, Miura T. Extensive resection and reconstruction of mediastinal trachea without prosthesis or graft: an anatomical study in man. *J Thorac Cardiovasc Surg* 1964;48:741.
4. Montgomery WW. Suprahyoid release for tracheal anastomosis. *Arch Otolaryngol* 1974;99:255.
5. Diaz-Jimenez JP, Lisbona RML. Benign Tracheal and Bronchial Stenosis. In: Diaz-Jimenez JP, Lisbona RML, editors. *Interventions in Pulmonary Medicine*. New York: Springer; 2013.
6. Nouraei SAR, Battson RM, Koury EF, Sandhu GS, Patel A. Adult post-intubation laryngotracheal stenosis: an underestimated complication of intensive care? *J Intensive Care Soc.* 2009;10(3):229.
7. Nikolaos Zias et al. 31 cases of Post tracheostomy and post intubation tracheal stenosis. *BMC Pulmonary Medicine* 2008, 8B18.
8. Flege JB Jr. Tracheoesophageal fistula caused by cuffed tracheostomy tube. *Ann Surg* 1967;166:153-6.
9. Schowengerdt CG. Tracheoesophageal fistula caused by a self-expanding esophageal stent. *Ann Thorac Surg* 1999;67:830-1.
10. Macchiarini P, Delamare N, Beuzebec P, et al. Tracheoesophageal fistula caused by mycobacterial tuberculosis adenopathy. *Ann Thorac Surg* 1993;55:1561-3.
11. Kelly JP, Webb WR, Moulder PV, Moustouakas NM, Lirtzman M. Management of airway trauma. II: combine injuries of the trachea and esophagus. *Ann Thorac Surg* 1987;43:160-3.
12. Gudovsky LM, Koroleva NS, Biryukov YB, Chernousov AF, Perelman MI. Tracheoesophageal fistula. *Ann Thorac Surg* 1993;55:868-75.
13. Muniappan A, Wain JC, Wright CD, Donahue DM, Gaiassert H, Lanuti M, Mathisen DJ. Surgical treatment of nonmalignant tracheoesophageal fistula: a thirty-five year experience. *Ann Thorac Surg* 2013; 95: 1141-6.
14. Martini N, Goodner JT, D'Angio GJ, Beattie EJ. Tracheoesophageal fistula due to cancer. *J Thorac Cardiovasc Surg* 59:319, 1970.
15. Andre Duranceau, M.D. Malignant Tracheoesophageal Fistula, *The Annals of Thoracic Surgery* Vol 37 No 4 April 1984.
16. Leonid M. Tracheoesophageal Fistulas. *Ann Thorac Surg* 1993;55B86&75.
17. Webb BD, Walsh GL, Roberts DB, Sturgis EM. Primary tracheal malignant neoplasms: the University of Texas MD Anderson Cancer Center experience. *J Am Coll Surg* 2006;202:237-246.
18. Macchiarini P et al. Primary tracheal tumours. *Lancet Oncol.* 2006 Jan;7(1):83-91.
19. Hermes C. Grillo. Primary Tracheal Tumors: Treatment and Results. *Ann Thorac Surg* 1990;49B69-77.
20. Ioan Cordos et al. Sixty tracheal resections – single center experience. *Interactive Cardiovascular and Thoracic Surgery* 8 (2009) 62–66.
21. Maddaus MA, Toth JL, Gullane PJ, et al. Subglottic tracheal resection and synchronous laryngeal reconstruction. *J Thorac Cardiovasc Surg* 1992;104:1443-50.
22. Douglas J. Mathisen, Subglottic Tracheal Resection, August 1998 Volume 3, Issue 3, Pages 142-153.
23. Mitchell JD, Mathisen DJ, Wright CD, et al. Clinical experience with carinal resection. *J Thorac Cardiovasc Surg* 1999;117:39-52. 10.1016/S0022-5223(99)70468-X.
24. Akshay Chauhan I, Satish Kumar Aggarwal. Cardiopulmonary Bypass for Tracheal Resection and Repair—A Safe Alternative. *World Journal of Cardiovascular Surgery*, 2018, 8, 197-203.
25. Prachi Kar, Amaresh Rao Malempati, Institution of cardiopulmonary bypass in an awake patient for resection of tracheal tumor causing near total luminal obstruction. *Journal of Anaesthesiology Clinical Pharmacology* | Volume 34 | Issue 3 | July-September 2018.
26. Marulli G, Rizzardi G, Bortolotti L, Loy M, Breda C, Hamad AM, et al. Single-staged laryngotracheal resection and reconstruction for benign strictures in adults. *Interact Cardiovasc Thorac Surg.* 2008;7:227-230.
27. Lano CF, Jr, Duncavage JA, Reinisch L, Ossoff RH, Courey MS, Netterville JL, et al. Laryngotracheal reconstruction in the adult: a ten years experience. *Ann Otol Rhinol Laryngol.* 1998;107:92-97.
28. Cordos I, Bolca C, Paleru C, et al. Sixty tracheal resections—single center experience. *Interact Cardiovasc Thorac Surg* 2009;8:62-5; discussion 65.
29. Grillo HC, Donahue DM, Mathisen DJ, Wain JC, Wright CD. Postintubation tracheal stenosis. Treatment and results. *J Thorac Cardiovasc Surg* 1995;109:486-93.