

ORIGINAL ARTICLE

Feasibility of various surgical options ranging from aggressive resections to conservative methods for managing tracheolaryngeal invasion by thyroid cancers

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ABSTRACT

Introduction: Tracheo-laryngeal resections in locally advanced thyroid cancer involve adequate anatomical knowledge and surgical skills to have improved outcomes and minimal morbidity. Surgical options range from aggressive resections with end to end anastomosis to various conservative methods. Benefits and improved outcomes with each surgical technique need to be weighed against the morbidity caused by them.

Aim and method: To review literature data available on tracheo-laryngeal resections in thyroid cancer and analyze the outcomes of surgery in terms of extent of surgery, adjuvant therapies, morbidity, recurrence rates, survival benefits and mortality.

Result and Conclusion: Major tracheo-laryngeal resections are safe, less morbid, improve survival rates and have lesser recurrence rates compared to conservative methods. Long term prospective studies are needed to have a higher level of evidence for such recommendations.

INTRODUCTION

Differentiated thyroid cancers usually have a very good prognosis with 10 years survival rates of > 90 %¹. Airway invasion is one of the independent adverse risk factor for higher local recurrence rates and mortality and hence this subgroup of patients needs much aggressive surgical management². Extra-thyroidal extension leads to bad prognosis with 10-year survival rates being 45% compared with 91% for those who have well encapsulated intra-thyroidal malignancy³.

Ishihara et al have described tracheo-laryngeal resection techniques as early as 1978 but high morbidity was also associated with them⁴⁻⁶. With time, surgical understanding has evolved and now such resections are resulting in lesser morbidity, reducing from 44% to 26 % and also peri-operative mortality reducing to 1.2%⁷.

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Tracheo-laryngeal invasion has been seen in up to 37 % of patients with locally advanced thyroid cancer⁸. Radioactive iodine has a beneficial effect in adjuvant setting in cases of well differentiated thyroid cancer. Most of these aggressive tumors have poorly differentiated thyroid cancer component and that may not respond to radioactive iodine ablation. These cancers do not respond well to radiation therapy or chemotherapy. Hence, complete surgical resection seems to be the best curative option^{9, 10}.

Tracheo-laryngeal resections in thyroid cancer have resulted in improving the outcomes in patients in terms of cure in locally advanced disease and also for palliation in metastatic settings¹¹. Incomplete resections or shaving may lead to recurrence and worse prognosis compared to complete resections with negative margins¹². Hence complete resections are recommended and adjuvant therapies like radiation therapy or radioactive iodine ablation

must not be used as a substitute for incomplete surgical resections.

Classification of Aerodigestive tract invasion by thyroid cancer¹³

As per the Union for International Cancer Control (UICC) and the American Joint Committee on Cancer (AJCC), thyroid cancer with tracheal invasion comes under T4a.

Modified Shin et al classification:

Adjacent	Shaving
Superficial	Shaving
Deep extraluminal	Window/sleeve resection
Intraluminal	Window/sleeve resection

Dralle classification¹⁴

1	Tumor extent maximum 2 cm vertical and max. 1/4 horizontal of the circumference	Window resection
2	tumor invasion >2 cm vertical and/or >1/4 horizontal of the circumference	Circumferential resection
3	Unilateral tumor invasion >2 cm vertical and/or >1/4 horizontal of the circumference; RLN resection required; oblique resection required to preserve the contralateral RLN; temporary tracheostomy	Circumferential resection
4	Unilateral or bilateral wall invasion >2 cm vertically and/ or >1/4 of the circumference; RLN can be preserved in some	Circumferential resection
5	Bilateral larynx invasion, invasion of the trachea >5–6 cm	laryngectomy
6	Esophagus involvement	cervical evisceration

It needs proper understanding of the surgical anatomy of trachea, larynx, cartilages, vascularity, muscles and adjacent structures and also surgical

skills and anesthesia support to accomplish these major resections with minimal morbidities. It is done in emergency settings in cases of critical airway narrowing or electively in other cases. Hence, we proposed to review the available literature on these various surgical resection options available to have better understanding of the outcomes of such aggressive surgical resections.

AIM AND METHODS

We reviewed the literature available in the published literature on tracheo-laryngeal resections in thyroid cancer and analyzed the data.

RESULT AND DISCUSSION

All the studies published on tracheo-laryngeal resections were of retrospective nature. The data on less or more aggressive surgery in such cases varied among all the studies and the debate for the extent of resection continues. These tumors usually occurred in older age group of patients.

Airway invasion by thyroid cancer is mostly a step wise method of invasion and tumor grows first horizontally then vertically within the mucosa/muscle layer before penetrating the lumen¹⁵. Hence, mostly the area of infiltration is much larger than seen by intraluminal devices like bronchoscopy. To precisely assess the extent and depth of tumor infiltration for achieving complete resection with clear margins we need to have CT scan or MRI in addition to bronchoscopy/ endoscopic ultrasound. Shin et al have classified tracheolaryngeal invasion based on depth and Dralle et al have classified based on the surgical extent of resection¹⁶. Trachea needs to be mobilized anteriorly and posteriorly and not laterally to avoid devascularizing it as main blood supply is laterally and also not to injure the recurrent laryngeal nerves.

Laryngo-tracheal invasion by thyroid cancer is an independent poor prognostic factor but major surgical complete resections have shown improved survival outcomes in such patients¹⁷. Airway obstruction is the main cause of death in such patients¹⁷. Hence, surgical intervention needs to be done in emergency settings in critical airway narrowing or in planned elective way in other scenarios.

In tracheo-laryngeal resections, anesthesia also plays a vital role and good co-ordination between the surgeon and anesthetist is needed¹⁸⁻²⁰. Fiberoptic nasotracheal intubation with flexible bronchoscope is useful in assessing the airway obstruction and intubating the patient. Tracheostomy is usually avoided as it leads to surgical bed contamination. Use of high frequency jet ventilation at time of tracheal resection and doing end to end anastomosis helps in maintaining adequate anesthesia²¹.

Shaving or tangential excision is described as an option for superficial tracheal infiltrations by thyroid cancer as per Shin stage of classification based on depth of invasion²². It is a simple procedure and does not involve major surgical resections. However, there is always a debate on being less or more aggressive in surgical approach as data is diverse and usually shaving is not recommended for deep invasive lesions as it violates the oncological principles by incomplete resections and results in higher local recurrence rates²³. With palliation and macroscopic remnant, 10 years survival in some studies has been shown to be up to 50 % which is much lower compared to 75-90% in cases of complete resection²³. The remnant tissue can grow and is the most common cause for airway obstruction and high mortality²³. Local recurrence rates with shaving have been found to be higher (17 %) compared with sleeve resection (6.5%)²⁴.

Lesions involving less than a quarter of tracheal circumference and less than 2cm vertically may be excised with window resection technique with muscle flap reconstruction. Along with window resection people have done airtight tracheocutanoestomy (TCS) and closure after 3 -6 months with muscle flaps²⁵. TCS is done by fixing tracheal mucosa and cartilage to skin by sutures and after 3- 6 months period either by primary closure or skin flap the defect is closed. Complications of TCS are wound infection, air leak, skin necrosis and granulation tissue. Risk factors for recurrence are tumor size > 4 cm and

age > 60 years. Adjuvant radiotherapy has been used in select group of high risk patients to avoid recurrence.

Tracheal sleeve resection and end to end anastomosis is a major surgical procedure but does not involve much morbidity. Sleeve resection may be done in a horizontal, oblique or stepwise manner depending on tumor site and surgical considerations. The maximum length of tracheal resections for primary anastomosis is up to 3.5cm without any release methods and up to 6cm with release methods (supra/ infra hyoid, inferior constrictor or hilar release). Laryngeal release by resecting the supra hyoid muscles add 2-2.5cm extra length for tension free anastomosis. Only disadvantage of these release maneuvers is the difficulty in swallowing and aspiration problems. Large segment tracheal resections (> 6 cm) may need other options like tracheal stenting, autologous tracheal substitution with patient's own skin, cartilage and ribs and microvascular anastomosis. In case of laryngeal invasion, crico-tracheal resection, partial laryngectomy with cricoid cartilage excision and then the defect being reconstructed by tracheal cartilage or total laryngectomy have been. Earlier, fixing of patient's chin to chest by suture/ braces was done to avoid any unnecessary extension of neck but this maneuver is now done in selected group of patients only.

Morbidity following tracheal sleeve resections reported in literature ranges between 8-37%²⁶. It includes mostly recurrent laryngeal nerve palsy or anastomotic dehiscences. Other complications may be tracheal stenosis, bleeding or infection. Early airway resection has shown better survival rates compared to delayed resections. Critical devascularization of the trachea occurs due to radical tumor removal, sacrifice of the strap muscles and concomitant pre- and para-tracheal lymph node neck dissection. Sternocleidomastoid muscle can be mobilized anteriorly to reinforce the anastomosis.

Table: List of clinical outcomes of various surgical procedures done in patients undergoing tracheal resection.

Study	Patient number	Study design	Median Follow up in months	Tracheal resection length max. (cm)	Morbidity	Mortality
C J Mutrie Ann Th Surg 2011	105	retro	36	1.5-6	4% (voice change) 17% dilation postop 7% tracheostomy-2% dependent	1%
N Wada Langenback 2006	64	retro	92.3		1 RLN palsy 8 trac dep 7 permanent hypocal	23% (complete surgery) 94% incomplete 14% conservative surgery
Grillo Ann Thor Surg 1992 ATS 2007	34 82	retro	4.4 yrs 8 YRS		2 recurr 1 granuloma 1 tracheal stenosis 4.3% anast dehiscence 4.3% perm tracheostomy	13 1.2%
Cordos 2009 ICVTS	60	retro	3mo-7yrs	4	1 REC 1 revision surgery	2 died (3.4%)
Eur Arch Otorhinolaryngol (2014)	6	retro	41mo	2-6	1- Anastomotic dehiscence and tracheo-innominate artery fistula 2-local recurrence.	2 died

Non-operative methods in patients who are not fit for surgery/ refuse surgery or need intervention for palliation only include laser, stenting, bronchoscopic guided curettage. Bronchoscopic CO₂ cryosurgery/ Argon plasma coagulation/ CT guided ¹²⁵I radioactive seed implantation/ balloon inflation has been tried in some series but mortality rate was found to be high as up to 23% in such patients and it may be a feasible option for palliation for inoperable patients.

CONCLUSION

Major tracheo-laryngeal resections are safe, less morbid, improve survival rates and have lesser recurrence rates compared to conservative methods. Long term prospective studies are

needed to have a higher level of evidence for such recommendations.

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