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MEDIASTINAL TRACHEOSTOMY- A REVIEW

Oncology

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ABSTRACT

Establishing an adequate airway through an end stoma after resection of laryngo-tracheal tumors with proximal tracheal involvement is always a challenge for a surgeon. As primary surgery and surgical salvage provides reasonable survival outcomes for many advanced laryngopharyngeal, tracheal, thyroid and esophageal neoplasms, the concept of establishing anterior mediastinal tracheostoma has come into picture. We describe the indications, feasibility, outcomes and techniques of mediastinal tracheostomy described in literature. Every surgeon dealing with head and neck malignancies should be well aware of the techniques to establish a mediastinal stoma if the scenario requires it.

INTRODUCTION

Achieving adequate length of tracheal stump in malignant lesions of larynx and upper trachea which need resection with adequate margins is a challenge. These tumors which need resection of retrosternal trachea require an anterior mediastinal tracheostomy to secure airway reconstruction. Need for a mediastinal stoma is established in clinical scenarios including malignancies of cervical esophagus, advanced or recurrent laryngopharyngeal malignancies, stomal recurrences, subglottic and tracheal malignancies and thyroid cancer. Occasionally mediastinal stoma is considered in scenarios like stricture of cervical tracheostoma, recurrent dehiscence in tracheal end to end anastomoses and large aero-digestive fistulas. An additional emphasis on achieving a well reconstructed upper digestive tract is also required in these scenarios.

STOMAL RECURRENCE

A plethora of synonyms are used to describe stomal recurrence which include tracheal/peri-tracheal/regional recurrence, tracheal/ stomal metastases and persistent para-tracheal tumor. (1)

Initially described by Keim etal (2) as " a diffuse infiltrate of neoplastic tissue at the junction of the skin and amputated trachea". Later this definition was modified to include advanced neck recurrences which included areas adjacent to stoma.(3–5) Incidence of stomal recurrence described in literature is about 5% to 25%.(1,6–8)

There are several pathophysiological mechanisms proposed for the etiology of stomal recurrence such as, microscopic or macroscopic residual tumor, lymphatic permeation phenomena or metastasis, implantation in operative field, lymphatic inversion phenomenon or tropism etc.(9)

In 1982 Sisson(10) has proposed a classification system for stomal recurrences and in 1989 (11) has updated it.

STAGE I – superior to stoma in 3 to 9 O' clock positions.

STAGE II – STAGE I + esophagus involvement or inferior to stoma without esophagus involvement.

STAGE III – below the stoma with esophagus involvement and/or early disease in mediastinum

STAGE IV – lateral extensions of tumor under clavicle.

Survival varies from 45% to 50% (5-year survival) for stage I to 0% to 2% 5-year for stage IV disease.(10,11)

With the advent of high resolution CT and MRI, preoperative assessment of operability has improved along with ruling out possibility of metastatic disease. Further planning the extent of resection with careful consideration of critical structures is vital.(1)

Atiyah etal (12)has developed a staging system with incorporation of investigations to assess operability, which describes stomal recurrence as:

STAGE I - disease superior to horizontal equatorial line drawn through stoma without esophageal involvement, trachea maybe involved but on CT/MRI there is no mediastinal involvement.

STAGE II- IIA-superior to equatorial line with esophagus involvement on CT/barium swallow

IIB-below the line without esophagus involvement.

STAGEIII-below equatorial line with confirmed esophageal involvement on endoscopy.

IIIA- mediastinal involvement is confined to proximal trachea of one side.

IIIB- bilateral disease confirmed on imaging and/or thoraco/mediastinoscopy.

STAGE IV- laterally under clavicle/s, inferior to aortic arch, posteriorly involving prevertebral fascia or encasement of both common carotids.

Surgery is generally not advocated for stage IIIB and IV.(12)

The basis of oncological resection of these lesions include a wide resection of tracheostoma, soft tissues of neck and chest wall, mediastinal dissection, manubrial/sternal resection and creation of an anterior mediastinal stoma. Stages IIA and IIIA require resection of esophagus with reconstruction of upper aero-digestive tract.(1)

Till date there are two meta-analyses on risk factors for stomal recurrence after laryngectomy.(7,8) Mei etal (7)meta-analysis of 44 studies showed advanced stage, positive margins, preoperative tracheostomy, subglottic involvement, node positive neck and postoperative pharyngo-peristomal fistula as independent risk factors. Wang etal (8) meta-analysis of 7 studies showed subglottic and transglottic spread, advanced stage (T4) and preoperative tracheostomy as independent risk factors.

The importance of paratracheal dissection to reduce the incidence of stomal recurrence was first proposed by Ogura and Bello(13), later this was strengthened by works of various others in patients with postcricoid and subglottic carcinomas.(14,15)Kowalski(16) described a technique of para and pretracheal nodes in a centripetal manner with inclusion of isthmus and medial portion of thyroid lobes. Kowalski etal(17) using a multivariate analysis showed that bilateral paratracheal dissection was a significant prognostic factor.

ADVANCED THYROID CARCINOMA

Incidence of laryngotracheal invasion by a well differentiated thyroid carcinoma is about 7% to 13%.(18–22) Other undifferentiated variants have a higher incidence of laryngotracheal invasion. Shin etal(23)has found a relation between depth of tracheal invasion and survival, he has proposed a staging system as follows:

Stage I - extension through the capsule of the thyroid gland and abuts the external perichondrium.

Stage II - invasion between the rings of cartilage or destroying the cartilage.

Stage III - extension through the cartilage or between the cartilaginous plates into the lamina propria of the tracheal mucosa.

Stage IV - extension through the entire thickness of and expansion into the tracheal mucosa.

Addressing advanced thyroid carcinomas with airway invasion is still a controversial issue. Few authors advocate shave resection while few others follow radical R0 resection. Extensive soft tissue involvement with airway compromise and laryngeal functional impairment would need radical resection in well and poorly differentiated carcinomas of thyroid. Appropriate airway establishment with esophageal reconstruction would be needed in such cases.(18,20–22)

Kim etal (21) in their study of 65 patients with aero-digestive tract invasion has reported simultaneous involvement of trachea and esophagus showed higher locoregional recurrence and laryngeal involvement showed lower disease specific survival. They have quoted that inspite involvement of aerodigestive tract, appropriate surgery would prolong overall survival.

SUBGLOTTIC CARCINOMA

The reported incidence of carcinoma of subglottic origin is rare and varies between 0.013% and 6%(24,25) It is not always possible to identify and distinguish between true subglottic or glottis carcinoma with subglottic extension, Nonetheless these tumours have propensity for early cartilage erosion, submucosal spread, airway compromise and lymphatic metastases. Lymphatics of the subglottic region drain into the pretracheal, prelaryngeal (Delphian) and paratracheal lymph nodes. These tumours also have high propensity for stomal recurrence and dismal survival outcomes compared to other laryngeal sites.(24,25) Role for mediastinal stoma in widely invasive subglottic carcinomas has been described in literature.(11,26–31)

HISTORY OF ANTERIOR MEDIASTINAL STOMA

Waddell and Cannon (32) have reported four cases of mediastinal tracheostomy achieved by construction of a skin tube anastomosed to the tracheal stump. Complication rates were significantly high with 50% of patients in their series died due to catastrophic innominate blowouts. This devastating complication was due to excessive tension on trachea leading to pressure necrosis of innominate artery. Sisson etal(10,11) also reported similar catastrophic complications in his series. The other problems included persistence of dead space due to upper mediastinal extirpation, tracheostomal separation due to giving away of tension sutures, exposure of great vessels, infection (mediastinitis and abscess), lung incarceration etc.(26,31) Waddell and Cannon(32) proposed relocation of tracheostoma inferior to innominate artery to avoid undue pressure on the artery. Grillo(28) proposed a technique of breastplate resection (manubrium ,medial clavicle ends, costal cartilages of first and second ribs on both sides) to solve the problem of dead space and constructed the stoma by mobilizing chest wall skin. Terz etal(33) reported a mortality rate of 38% in a multicenter series of 21 patients operated using Grillo's(28)technique. Mark B. Orringer(27,29,34) made significant contributions in reducing surgical complication, he has emphasized on the value of relocation of stoma inferior to innominate artery. Majority of his series were cervical exenterations for esophageal carcinomas, he routinely performed gastric pullups with anastomotic leaks complicating 30% of his patients. He employed colonic interposition as method of choice to restore digestive continuity in his latter series. Biller etal(35) in 1980 has adapted pectoralis major myo-cutaneous island flap to fill dead space and achieve good stomal separation from innominate artery. Since then this technique has emerged as the gold standard in construction of anterior mediastinal stoma.(26,30,31,36–43)

AUTHOR (YEAR)	SITE	NO. OF PATIENTS WITH MEDIASTINAL STOMA	SURVIVAL
Axelsen etal(44) (1995)	Squamous cell carcinoma of trachea	1	Alive at 1 year follow up
Berthet etal (45)(2014)	Stomal recurrence	10	53 months 5 year median DFS
	Advanced papillary thyroid carcinoma	2	
Chan etal (46) (2011)	Stomal recurrence	9	55.6% OS at 5 years
	esophageal carcinoma	4	
	Subglottic/upper tracheal tumour	4	
	Thyroid malignancy	3	
Conti etal (26)(2010)	Stomal recurrence	5	43% OS at 5 years
	Esophageal carcinoma	2	
	Subglottic carcinoma	4	
Fodor etal(47) (2017)	Stomal recurrence	1	Alive at 2 year follow up
Gomes etal (1987)	Sarcoma	1	Alive at 9 months follow up
	Thyroid malignancy	1	Dead at one month
Gómez etal(36) (2007)	Stomal recurrence	1	Alive at 1 year follow up
Grillo etal(48) (1990)	Stomal recurrence	2	Nil alive at 3 years
	Esophageal carcinoma	7	One patient alive at 3 years
	Subglottic malignancy	3	2 patients alive at 3 years
	Thyroid malignancy	3	2 patients alive at 3 years
Orringer etal(29) (1992)	Stomal recurrence	5	2 patients alive at 3 years
	Advanced laryngeal/pharyngeal carcinoma	15	nil alive at 3 years
	Esophageal carcinoma	16	2 patients alive at 3 years
	Thyroid malignancy	2	1 patient alive at 3 years
Kato etal (49)(1994)	Esophageal carcinoma	16	nil alive at 3 years
Maipang etal (30)(1996)	Esophageal carcinoma	6	1 patient alive at 3 years
	Thyroid malignancy	4	1 patient alive at 3 years
Kuwabara etal (50)(2001)	Esophageal carcinoma	7	2 patients alive at 3 years
Kimura etal(51) (1994)	Esophageal carcinoma	1	Died due to metastases at 6 months
Martintod etal(52) (2011)	Stomal recurrence	1	Alive at 1 year follow up
Stell etal(53) (1970)	Stomal recurrence	7	5 patients alive at 4 years

SURGICAL TECHNIQUE

Prerequisites to these morbid surgery include good general condition of patient, distal trachea should be macroscopically free of tumor for at least 5 centimeters, ability to achieve R0 resection. Patient is positioned supine, cervical (elliptical for stomal recurrence around stoma) and median skin incision at manubrium are drawn along with PMMC island markings. Fibreoptic endoscopy could be used to assess the lower extent of tracheal involvement and establishing achievability of an adequate tracheal stump. Thoracoscopy can be planned to assess resectibility in case of doubtful imaging findings.(54) Limited bony resection involves a U-shaped subtotal manubrium resection with partial clavicular heads removal preserving adjacent first and second paired rib cartilages. This limited bony resection allows sufficient access to retrosternal trachea and to achieve cervical exenteration. This technique also avoids complications (flail chest, lung incarceration, poor cosmesis etc.) associated with extensive breast plate resection technique described by Grillo(28). This technique can be modified and extended to one or both sides depending on tumor characteristics. Bone edges are smoothened and bone wax applied. In case of need for esophagectomy along with retrosternal tracheal resection an additional abdominal laparotomy incision would facilitate a two team approach for gastric pullup or colonic interposition to reconstruct digestive tract .A feeding jejunostomy is routinely performed. An additional oblique incision connecting PMMC Island to median sternal incision would facilitate pectoral fascia dissection and flap inset in the defect created covering great vessels. Surgeon can visualize Innominate artery superiorly and left innominate vein inferiorly located ventral to the trachea after bony resection. Endoscopy could be used during resection to visualize the lower extent of tracheal involvement and achieving an adequate margin. Cervical and mediastinal nodal dissection and on demand thyroidectomy can be completed after primary resection. Mediastinoscopy assistance can also be used for mediastinal nodal clearance. If the remaining trachea is long enough to construct a tracheostoma above innominate artery, the distal trachea can be tunneled out through a muscular fenestration created in the inferior portion of the PMMC flap. This way muscle bulk can be interposed between remnant trachea and innominate artery. When the tracheal stump is short or in scenario of high lying innominate artery stoma should be relocated below the innominate artery. Division of left innominate vein may be usually required to create sufficient space for the stoma, in this scenario PMMC should be routinely planned on right side to avoid potential flap congestion and necrosis. Tracheal stump is superiorly sutured to skin of PMMC Island and inferiorly and circumferentially to mobilized sternal skin. Suction tubes are secured to drain the mediastinum and neck wounds. Chest and abdominal wounds are closed over drains. Postoperatively patient may require elective ventilation for an average of 12 hours in intensive care unit because of the magnitude and length of surgery. A low pressure cuffed tracheal cannulation may be needed for few days postoperatively.(31) Advantages of PMMC flap are it obliterates dead space and covers great vessels, prevents mediastinal infection in who sustain a salivary or pharyngo-digestive anastomotic leak, provides sufficient cutaneous cover, prevents undue tension on tracheostoma, could be considered for re-irradiation immediately after wound healing, etc.(26,30,31,36–39,41–43)

ALTERNATIVE TECHNIQUES

Elongation of tracheal stump by means of Free flap procedures have also been described in literature.(55,56) Caliceti etal described a technique of funnel shaped inset of Anterolateral thigh free flap. Residual tracheal stump of less than 5 cm is a huge challenge, but with advent of cryopreserved arterial allografts supra-aortic trunk resection and reconstruction is now possible.(45,48)

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