Malignant Tracheal Tumors

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Introduction

Tracheal tumors are quite rare, and about 90 % are malignant. The two most common malignant tracheal tumors, squamous cell and adenoid cystic carcinomas, have an equal incidence. Less common tumors include mucoepidermoid carcinomas, sarcomas, carcinoids, lymphomas, and melanoma (Gaissert et al. 2004, 2006). Common symptoms include dyspnea, cough, hemoptysis, wheeze (or "asthma"), stridor, and hoarseness. Distant metastases are rare.

Initial evaluation is with chest radiography, followed by contrast-enhanced chest CT with multiplane reconstruction. The degree of obstruction can be assessed accurately with CT. An estimate of the extent of longitudinal spread, the most important factor in determining resectability, also may be ascertained by reviewing the CT scan. Bronchoscopy, the next step, is performed for biopsy; assessment of lesion length, submucosal spread, and length of normal trachea; and relief of obstruction, if necessary. Rigid bronchoscopy is preferred for generous biopsy specimens and for relief of obstruction. Obstructing tumors typically are débrided endoscopically, and the base is treated with YAG (yttrium-aluminium-garnet) laser to reduce bleeding. Definitive resection rarely is emergent, as obstruction usually is relieved easily by bronchoscopic means.

Most patients who present with a tracheal tumor can undergo resection by an experienced airway surgeon (Gaissert et al. 2009). Resection length less than 4 cm is a favorable finding, but occasionally tumors up to 6 cm long may be resected if the patient is otherwise an excellent candidate. Factors affecting resectability include tumor length, body habitus, neck mobility and length, invasion of adjacent structures, metastatic disease (rare), age, and comorbid factors. The ideal patient is young, thin, and flexible with a long neck. Through experience, surgeons learn to what extent the negative prognostic factors influence how much of the trachea can be resected safely. Previous radiation therapy and resection are strong negative factors when considering resection. If patients are started on steroids for airway obstruction, they should be tapered off quickly and the resection done off steroids. Currently, there rarely is a role for preoperative induction therapy.

Tumors in the upper third of the trachea are approached by a cervical collar incision, those in the middle third by a combined cervical and mediastinal incision (a collar incision followed by a partial upper sternotomy), and those in the lower third usually by a right thoracotomy on top of the fifth rib. Occasionally, I resect long tumors extending down close to the carina by a full sternotomy so that bilateral hilar releases can be done, realizing access to the anastomosis will be somewhat challenging.

Patients are informed of the probable need for adjuvant radiation therapy after satisfactory recovery from tracheal resection. Patients with close or positive margins usually are referred for adjuvant radiation after control bronchoscopy 1 or 2 months after resection has demonstrated a well-healed anastomosis.

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Figure 8.1

After general endotracheal anesthesia is established, the endotracheal tube usually is placed beyond the tumor under bronchoscopic guidance in all but the most distal tumors. Airway obstruction should not be a concern, as it should have been dealt with previously if it was critical. Most patients undergo resection from the front, and this figure illustrates a cervicomediastinal exposure, which is probably the most common incision used. The patient's head is placed and stabilized in a gel ring, and an inflatable bag is placed and inflated under the shoulders to extend the neck as much as possible. The neck and chest are prepared and draped in the usual sterile fashion. First, a low collar incision is made, then it is deepened through the platysma. Subplatysmal dissection is done superiorly to the thyroid cartilage and inferiorly to the clavicles. Gelpi retractors are placed to expose the wound. The strap muscles are separated in the midline, and the thyroid isthmus is divided at the top of the airway. The anterior wall of the trachea is exposed from the thyroid cartilage to the carina by incising the deep layer of the deep cervical fascia (the pretracheal fascia) and dissecting the loose areolar tissue in this plane, first with the scissors followed by a finger into the mediastinum. Next, a vertical T extension is made inferiorly by a partial upper sternotomy, typically down to the third rib. When dividing the sternum with either a saw or a Lebsche knife, one should finish the sternotomy by going to one side of the sternum into a rib interspace so that the sternum will spread easily. If exposure is challenging, it sometimes is helpful to transect the sternum horizontally at the third interspace level to allow maximal sternal spreading. A small sternal retractor is placed followed by a retractor in the mediastinal tunnel under the vessels to fully expose the airway. With a headlight and experience, one can learn to resect and reconstruct relatively distal tumors via this anterior approach. The sternotomy may be extended to a full sternotomy if bilateral hilar release is deemed necessary because of anastomotic tension. Usually, the outside of the trachea is relatively normal, so the proximal tracheal transection site is difficult to determine. A useful maneuver, shown here, is for an assistant to use a bronchoscope to aid in accurately localizing the extent of the tumor before an incision is made. A 25-gauge needle is used to pierce the trachea at the proposed incision site under bronchoscopic guidance, and the site may be marked with a stitch or sterile marker. This maneuver may be repeated for the distal site as well, minimizing "wasted" tracheal resection and tension on the reconstruction

Figure 8.2

The trachea is dissected circumferentially over the length of the tumor and 7–10 mm beyond the proposed incision sites. Dissection is kept close to the airway laterally to avoid injury to the recurrent nerves. Care is taken when dissecting posteriorly to avoid entering the esophagus. If the posterior dissection is difficult, it is best to defer it until the airway is divided, when it becomes much easier to dissect. No attempt is made to radically resect paratracheal nodes, but adjacent nodes are removed if visible. To prepare for control of the airway once it is divided, a sterile endotracheal tube is placed on the field, with sterile extension tubing to connect it to the anesthesia machine. A final decision is made regarding resectability before the trachea is opened. If the portion requiring resection seems too large to allow comfortable reapproximation, one may reconsider and treat the tumor with radiation. This should be a rare occurrence, however, as the combination of CT and bronchoscopy allows a very accurate estimation of the length that needs to be resected. The cuff of the indwelling endotracheal tube is deflated before the trachea is cut. When the trachea is opened adequately, the endotracheal tube is pulled back to well above the proximal division site so it is out of the way. The on-field sterile endotracheal tube is placed in the distal airway as needed to ventilate the patient. If the esophageal muscle is invaded, it usually can be resected readily by cutting the muscle above the invasion site, finding the submucosal plane, and dissecting it to below the area of invasion. The trachea usually is held securely by two Allis clamps, one on either side of the cartilaginous rings. The esophagus usually is easy to dissect by elevating the trachea forward; furthermore, mobility is assessed readily by traction on the trachea. Also, one usually can further dissect anteriorly along the main bronchi under the main pulmonary arteries to gain additional release of the distal airway with the airway under tension with Allis clamps. The margins achieved depend on the pathology of the tumor and the extent of resection. Obviously, the goal is microscopically negative margins, although that is not always possible to achieve. Negative margins are hardest to achieve in adenoid cystic carcinoma, which has extensive submucosal and perineural spread. Tension always has to be weighed against margin status when deciding whether to resect more trachea. Essentially, grossly negative margins should always be achieved. When more trachea can be resected, if needed, separate margins should be sent for frozen section analysis. If the maximal amount of airway that can be resected is removed, there is little need for frozen section analysis of the margins, as the information received will not affect decision making in that case

Figure 8.1

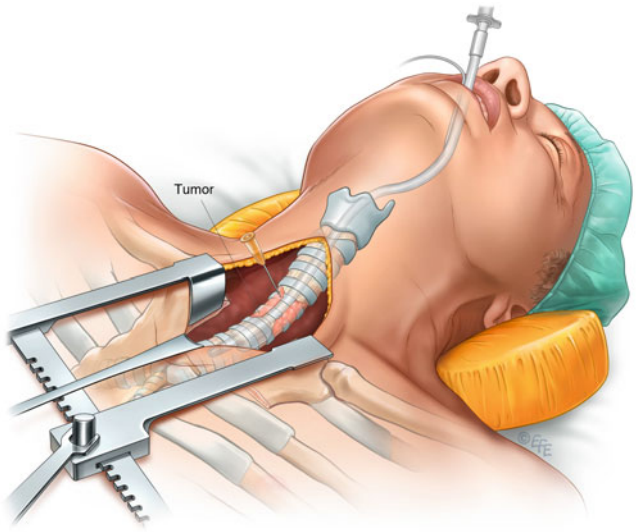


Figure 8.2

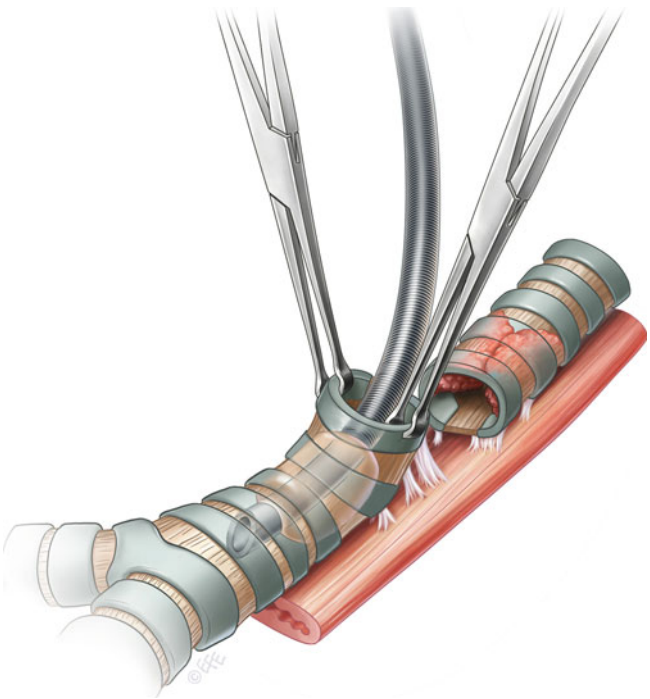


Figure 8.3

Lateral 2-0 Vicryl stay sutures are placed at about 3 and 9 o'clock on the two ends of the divided trachea to facilitate reapproximation of the trachea. These sutures are placed at least one ring back from the cut edge and encircle at least one ring of the trachea for adequate strength. They are clipped with Kelly clamps to distinguish them from the 4-0 sutures used to complete the anastomosis, which are clipped with regular hemostats. Intermittent ventilation is carried out with the sterile endotracheal tube as needed. Trial approximation is done after suture placement to assess the anastomotic tension. The anesthesiologist is asked to flex the patient's head mildly to simulate deflation of the bag under the shoulders. If there is easy approximation, nothing further need be done. If there is moderate tension, the airway is mobilized further by making sure the anterior pretracheal plane is completely free from the thyroid cartilage to the distal main bronchi. If there is significant tension, additional release maneuvers are necessary. If the proximal transection site is in the top half of the trachea, the easiest maneuver is a suprahyoid release, which usually produces at least 1 cm of tracheal devolvement (Montgomery et al. 1974). A separate incision is made over the hyoid bone, and the incision is deepened until it reaches the hyoid bone. Via cautery, the muscles attaching the hyoid to the tongue are detached from the superior aspect of the hyoid bone until the retroepiglottic space is reached. Dissection of these muscles is continued until the stylohyoid processes are reached. These are the lateral limits of dissection. The submucosa of the pharynx is dissected off the back of the hyoid bone laterally just medial to the stylohyoid process, and the hyoid bone is cut there to allow the larynx to drop about 1 cm. For a distal release, the sternum must be opened fully and both pleural spaces entered. The inferior pulmonary ligaments are lysed first, then bilateral hilar releases are done by incising the pericardium around the hilar vessels starting at the inferior vein level. The pericardium is cut anteriorly as well as posteriorly up to the pulmonary artery. Care is taken to avoid injury to the phrenic nerve. The right side is easy to release, but the left side often is difficult because of hemodynamic compromise from retraction of the heart. If this occurs, one can release the left side from within the pericardium as long as the position of the phrenic nerve is continuously and carefully monitored. Likewise, a hilar release usually allows 1 cm of airway to advance superiorly

Figure 8.4

Next, circumferential 4-0 Vicryl interrupted sutures are placed starting from the middle of the posterior wall, then working around the circumference of the trachea. Each suture is tagged by clamping it with a straight hemostat, then carefully clipping the hemostat to the drapes radially so that the last suture placed is most superficial. The sutures are then tied sequentially in the reverse order with the anterior ones first, followed by the lateral ones and finally the posterior ones. Keeping these sutures in careful order is important, as typically about 30 sutures are placed. Sutures are placed about 3 mm apart and approximately one tracheal ring deep. Another suture material, such as polydioxanone (PDS) or Monocryl (Ethicon, Somerville, NJ), may be used as long as it is absorbable. Exposed suture in the lumen tends to form granulomas, so this must be minimized. Intermittent ventilation is carried out with the sterile endotracheal tube between sutures as needed. Usually, four or five sutures may be placed during each apneic spell. Once all the sutures are placed, the sterile endotracheal tube is removed, airway toilet is performed to remove inspissated blood, and the proximal normal endotracheal tube is advanced across the anastomosis to the distal trachea. Care is taken to avoid catching and dragging sutures with the tip of the tube. After suture placement is complete, the inflatable bag under the shoulders is deflated and one blanket is placed under the head roll to flex the head and devolve the trachea. The Gelpi retractors are loosened slightly to ensure there is no impairment of airway mobility. The 2-0 Vicryl sutures are then crossed on each side, and one side is tied after satisfactory tracheal approximation is achieved. This is facilitated by having the assistant pull all the anterior sutures superiorly and, if necessary, pushing the distal trachea superiorly with a cotton peanut pusher. The other 2-0 Vicryl suture is tied, followed by the anterior 4-0 sutures from one 2-0 stay to the other. One stay suture is put on tension and pulled anteromedially to help expose the lateral and posterior trachea. The lateral, then posterior sutures are then tied. The wound is irrigated to remove any residual saliva. A leak test is done by deflating the endotracheal cuff and giving a breath hold of 20–30 cm of water, looking for any air bubbles around the anastomosis. The surgeon then unscrubs and performs bronchoscopy to inspect the anastomosis by pulling the endotracheal tube back under direct vision, looking especially for loose sutures and separations and correcting them if found. The anterior aspect of the anastomosis is separated from the innominate artery either by suturing the thyroid back over the trachea or rotating a strap muscle flap over the anastomosis. A small suction drain is placed next to the airway and removed on postoperative day 2 in the absence of excessive drainage or air leakage. The sternum is closed in the usual fashion with wires, then in layers. The strap muscles are reapproximated, followed by the platysma and skin. A guardian chin suture is placed from the undersurface of the chin to the anterior chest with heavy suture material to prevent hyperextension of the head. This suture does not suture the chin to the chest and usually is rather loose; its purpose is only to prevent inadvertent hyperextension. Patients are always extubated after tracheal resection because they essentially have normal airways, so there is no reason to ventilate them. Patients usually make a quick, uneventful recovery and are mobilized the next day. To ensure proper healing of the anastomosis, a control bronchoscopy is performed on postoperative day 5, 6, or 7, depending on the speed of recovery and tension on the anastomosis. Separation, necrosis, and granuloma formation are especially looked for during the control bronchoscopy. At this point, the chin stitch usually is cut; patients rarely lift their heads above neutral for several weeks thereafter. If adjuvant radiation treatment is necessary, bronchoscopy is repeated in 1–2 months to make sure the anastomosis is fully healed before therapy begins. If sloughing tissue still is present, radiation treatment should be delayed. Patients are followed up with periodic CT scans and bronchoscopy

Figure 8.3

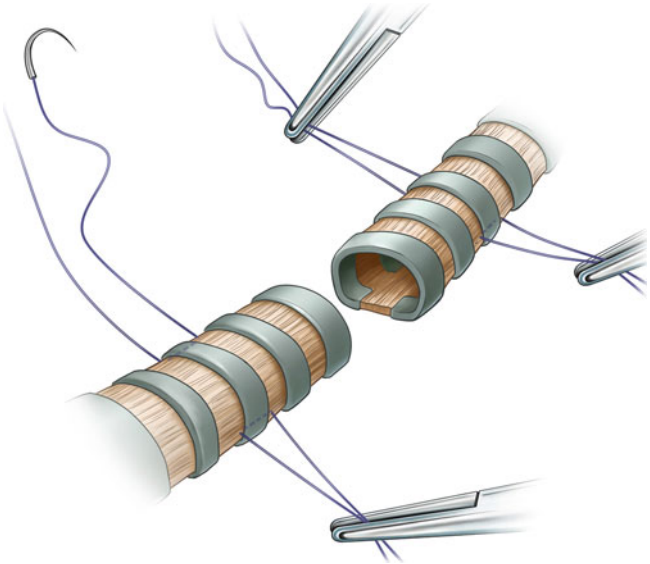
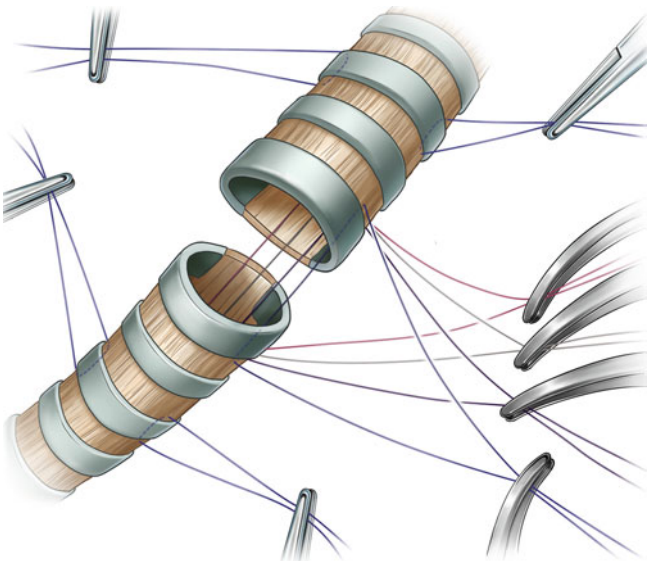


Figure 8.4



Conclusion

In our series, about 70 % of malignant tumors and almost all benign tumors were resectable (Gaissert et al. 2004; Honings et al. 2010). About 40 % of patients with malignant tumors had microscopic positive margins, and around 20 % had positive lymph nodes. Recent perioperative mortality has been about 3 %. Anastomotic complications occurred in 15 % of patients. Five-year survival was 39 % in patients with resected squamous cell carcinoma but only 7 % in those with unresected tumors. Five-year survival was 52 % in patients with resected adenoid cystic carcinoma, 33 % in those with unresected disease. Complete resection was a favorable prognostic factor. Disease-free survival was significantly longer after resection in patients with negative airway margins and no extramural disease, perineural growth (adenoid cystic carcinoma), or lymph node metastases. Adenoid cystic carcinomas may recur very late, so these patients must be followed up for the rest of their lives.

The most important aspect of the initial evaluation of a patient with a tracheal tumor is the resectability of the tumor, which primarily is a function of the length of involvement of the trachea. Knowing the tumor's pathology helps determine resectability, as adenoid cystic carcinomas almost always have more extensive submucosal and perineural spread than is readily apparent. This aspect of the tumor's biology must be recognized when deciding whether to resect an already long lesion, as it is always worse in the operating room at tracheal division. Tumors up to 4 cm almost always can be resected, but caution must be used when that length is exceeded. A good general rule to follow in the operating room is that if the resection is long and the surgeon is thinking about performing a hilar or suprahyoid release, he or she should do it. With longer resections, only experience can help guide the surgeon as to what is possible in his or her attempt to gauge anastomotic tension before committing to the resection.

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