RadioGraphics

CT Findings after Laryngectomy[1]

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CME FEATURE

See accompanying test at http://www.rsna.org/education/rg_cme.html

LEARNING OBJECTIVES FOR TEST 5

After reading this article and taking the test, the reader will be able to:

- Describe the surgical techniques used to treat laryngeal cancer.
- Recognize the anatomic changes that are associated with each type of laryngeal surgery.
- Differentiate the CT appearance of persistent or recurrent disease from that of normal postsurgical changes.

TEACHING POINTS

See last page

The goal of surgical treatment of laryngeal cancer is to achieve tumor control while preserving, whenever possible, the three primary functions of the larynx: breathing, swallowing, and phonation. The surgical procedure may consist of either a partial, conservative excision (eg, cordectomy, vertical partial laryngectomy, horizontal supraglottic laryngectomy, supracricoid laryngectomy with cricohyoidopexy or cricohyoidoepiglottopexy, or near total laryngectomy) or a radical excision (total laryngectomy). The procedure depends largely on the location and extension of the tumor, the stage of disease, and the patient's needs and preferences. Familiarity with the typical imaging appearance of the larynx after each procedure is crucial for differentiating normal postsurgical changes from persistent or recurrent disease as well as for diagnosing associated second primary malignancies. Since computed tomography (CT) is often used for follow-up evaluations, an ability to interpret the characteristic CT features is particularly important.

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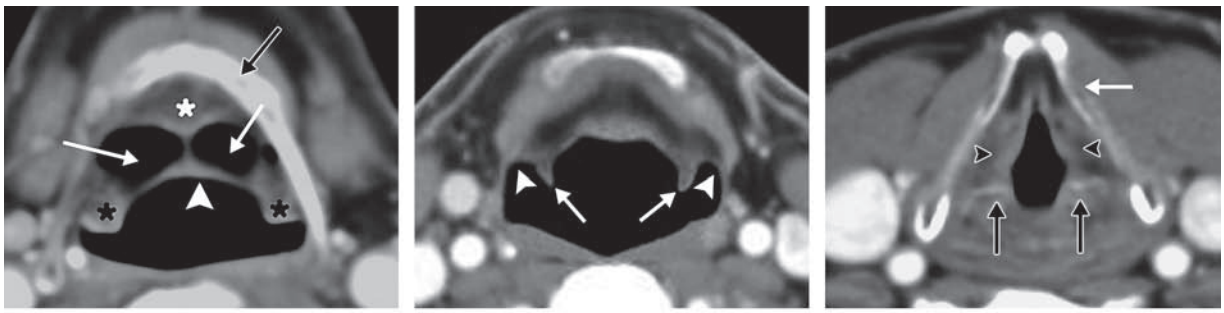


a. b. c.

Figure 1. Normal laryngeal anatomy. Axial images from computed tomography (CT) show the principal structures of the supraglottic larynx, from its superior to its inferior limits: in **a**, the free edge of the epiglottis (arrowhead), valleculae (white arrows), preepiglottic fat (white *), paraglottic spaces (black *), and hyoid bone (black arrow); in **b**, the aryepiglottic folds (arrows) and piriform sinus (arrowheads); and in **c**, the thyroid cartilage (white arrow), false vocal cords (arrowheads), and arytenoid cartilages (black arrows).

Introduction

The larynx is one of the most common sites of head and neck cancers (1,2). For purposes of anatomic description, the larynx may be considered to consist of the following three subdivisions: the supraglottic area (Fig 1); the glottic area, which contains the true vocal cords and mucosa of the anterior and posterior commissures (Fig 2); and the subglottic area, which extends to the inferior border of the cricoid cartilage (Fig 3) (3). Although these laryngeal subdivisions are based on anatomic and not functional differences, the clinical behavior of laryngeal tumors varies according to their location in the larynx. A tumor may spread from one area of the larynx to another (4).

Teaching Point

The optimal treatment for cancers of the larynx is a subject of controversy (5,6). Treatment decisions depend on several factors, including the tumor location, the disease stage, and the patient's needs and preferences (7). Various treatment modalities may be used (8). Generally speaking, early-stage disease may be treated either with radiation therapy or surgery; both modalities have similar outcomes (9). Advanced-stage local or regional disease may be treated with surgery followed by adjuvant radiation therapy, with radiation therapy alone, or with concurrent radiation and chemotherapy (10).

Several surgical techniques have been developed to treat laryngeal carcinoma according to the disease stage and the tumor location (11,12). These techniques may be described under the general rubric of partial (conservative) laryngectomy or total (radical) laryngectomy (Tables 1, 2). Whereas total laryngectomy results in a complete loss of vocal function, partial laryngectomy involves the preservation of a portion of the larynx so that vocal sounds can be produced. In addition, respiration is preserved (usually without a permanent tracheostomy), and swallowing is possible without aspiration (13).

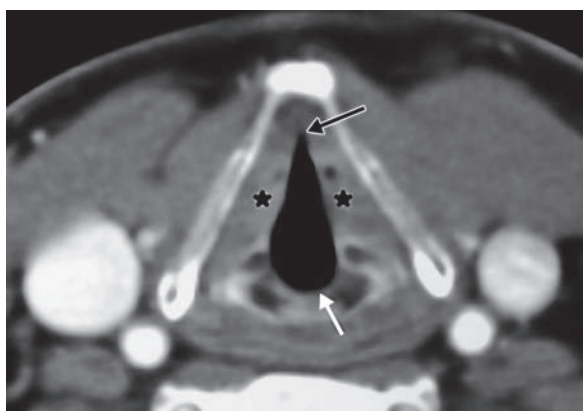


Figure 2. Normal laryngeal anatomy. Axial CT image at the level of the glottis shows the true vocal cords (*) and the anterior (black arrow) and posterior (white arrow) commissures.

Teaching Point

Follow-up after laryngectomy includes clinical and endoscopic evaluations. Primary laryngeal malignancies usually arise from the mucosal surface and are accessible for biopsy at endoscopy. In contrast, deep submucosal recurrences and second cancers are more readily detected at radiologic imaging (14). CT, in particular, is widely used for the regular monitoring of patients who have undergone surgical treatment of laryngeal carcinoma (15–17).

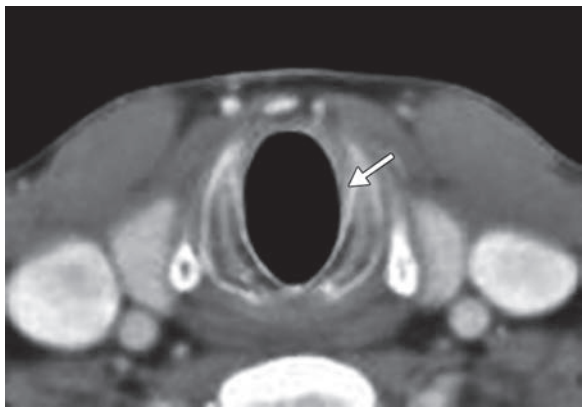


Figure 3. Normal laryngeal anatomy. Axial CT image shows the subglottic larynx, which extends from the inferior limit of the true vocal cords to the inferior part of the cricoid cartilage (arrow).

Table 1
Laryngectomy Procedures

Conservative procedures
Endoscopic laser excision and cordectomy
Vertical partial laryngectomy
Frontolateral laryngectomy
Hemilaryngectomy
Horizontal laryngectomy
Supraglottic
Extended supraglottic
Three-quarters
Supracricoid
With cricohyoidopexy
With cricohyoidoepiglottopexy
Near total laryngectomy
Radical procedure
Total laryngectomy

The article describes the anatomic changes in the laryngeal supportive structures or framework (the cartilages and hyoid bone) and in the endolaryngeal soft tissues that are observed after each partial or total laryngectomy procedure (18, 19). When reading postsurgical CT scans, radiologists should take into account the type of resection performed, irregularities in the shape of the remaining soft tissues of the larynx, and the complete or partial absence of adjacent cartilaginous structures (20). The surgical reconstruction technique may be identified by considering the relationship of the remaining cartilages to the hyoid bone.

Teaching Point

Table 2
Surgical Options for Localized and Advanced-Stage Cancers

Glottic cancers
Endoscopic laser excision and cordectomy
Vertical partial laryngectomy
Supracricoid laryngectomy with cricohyoidoepiglottopexy
Supraglottic cancers
Horizontal supraglottic laryngectomy
More extensive disease
Three-quarters laryngectomy
Supracricoid laryngectomy with cricohyoidopexy
Near total laryngectomy
Total laryngectomy

Note.—Laryngeal tumors with a subglottic origin are rare, usually detected at an advanced stage, and generally treated with radical surgery (total laryngectomy).

An understanding of the morphologic changes that occur in the larynx subsequent to laryngectomy allows the radiologist to distinguish persistent or recurrent disease and second primary malignancies from normal postsurgical changes (21).

Surgical Treatment Options

Various surgical procedures may be used to remove cancer while preserving or reconstructing laryngeal structures to allow continued functioning of the larynx in breathing, swallowing, and speaking (22). Partial (conservative) laryngectomy and radiation therapy result in similar rates of survival and local control; however, for superior results with regard to voice preservation, patients with early-stage glottic carcinomas usually undergo radiation therapy instead of surgery (23).

The lesions most suitable for conservative laryngeal surgery are those that, because of their local invasiveness or proximity to cartilage, are not readily curable with radiation but are small enough to allow adequate resection without sacrificing the entire larynx. Partial laryngectomy also may be a safe and effective treatment for selected cases of recurrent or persistent early-stage cancer that has proved refractory to primary

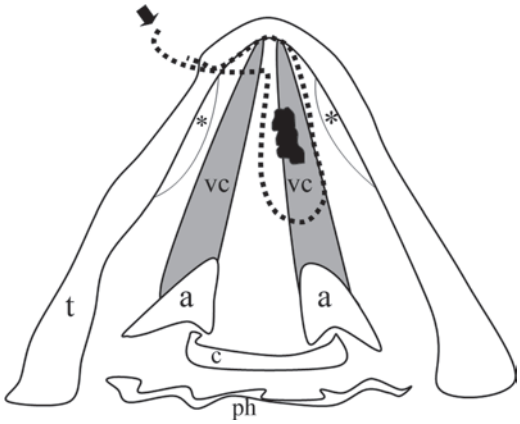


Figure 4. Axial schematic shows the structures excised (area inside dotted lines) in cordectomy: the true vocal cord *(vc)*, vocalis muscle, and tendon. Also depicted are the arytenoid *(a)*, cricoid *(c)*, and thyroid *(t)* cartilages; the false vocal cords (*); and the pharynx *(ph)*. The tumor is shown in black.

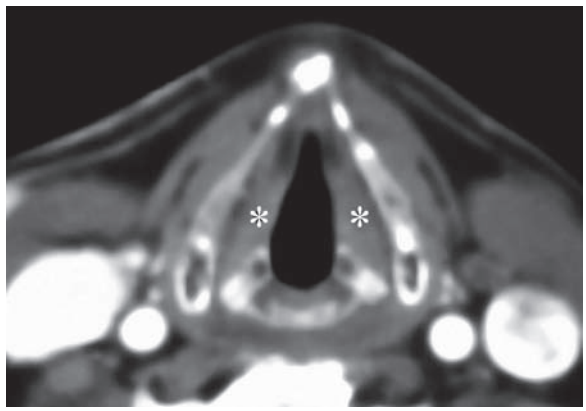


Figure 5. Postsurgical CT scan at the level of the glottis in a 76-year-old man shows regenerated mucosa of the vocal cords (*) and other glottic structures that have a normal appearance 4 years after a left cordectomy and 1 year after a right cordectomy. Both cordectomies were performed for lesions that were confined to the true vocal cords.

radiation therapy. Total (radical) laryngectomy may be held in reserve as a last option for salvage (24,25).

Endoscopic Laser Surgery and Cordectomy

If a laryngeal cancer is unilateral, is limited to the true vocal cord, and does not impair cord mobility, endoscopic surgery with the use of a carbon dioxide laser for excision is preferred over open surgical approaches such as midline thyrotomy with cordectomy (26). Only the true vocal cord and the vocalis muscle and tendon are excised (Fig 4). After surgery the cord regenerates, and subsequent CT scans show no abnormalities (Fig 5).

Vertical Partial Laryngectomy

Vertical partial laryngectomy may be performed for treatment of early-stage glottic cancers that

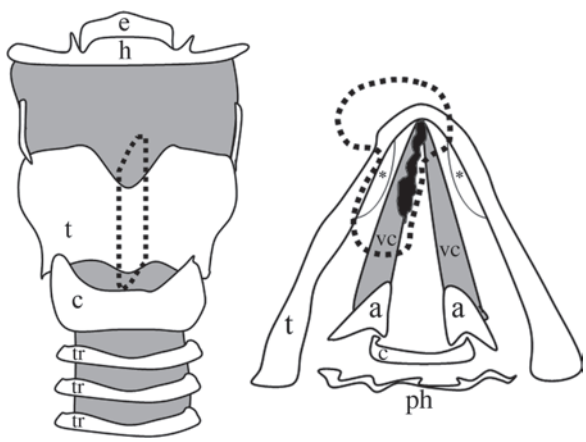
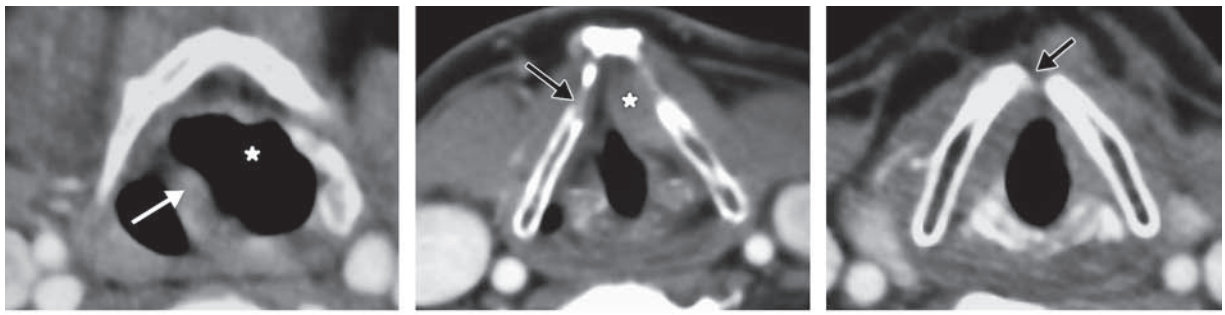


Figure 6. Frontal and axial schematics show the structures excised (area inside dotted lines) in vertical partial laryngectomy. Left: First, a vertical segment of the thyroid cartilage *(t)* is excised. Right: Next, one vocal cord *(vc)*, the ventricle and the false cord (*), the anterior commissure, and a small anterior portion of the contralateral vocal cord are removed. The tumor is shown in black. *a* = arytenoid cartilage, *c* = cricoid cartilage, *e* = epiglottis, *h* = hyoid bone, *ph* = pharynx, *tr* = tracheal ring.



a. b. c.

Figure 7. Follow-up CT scans obtained in a 50-year-old man after a frontolateral partial laryngectomy for a tumor involving the left vocal cord and the anterior commissure. **(a)** Axial image at the level of the hyoid bone shows absence of the left aryepiglottic fold and thickening of the right aryepiglottic fold (arrow) as a result of surgery. There is less preepiglottic fat, and the neovestibule (*) is asymmetric. **(b)** Image at the level of the glottis shows the absence of part of the left thyroid cartilage and a gap in the right thyroid cartilage (arrow) where the paramedian incision was made. The glottic symmetry is distorted by a soft-tissue scar (so-called pseudocord) near the left inferior thyroid cartilage (*). Note that both arytenoid cartilages were spared. **(c)** Image at a slightly lower level than **b** shows an anterior postsurgical defect of the thyroid cartilage with a sclerotic border (arrow).

involve the vocal cord and extend as far as the anterior commissure or the arytenoid cartilage, characteristics that apply to a broad range of lesions. Because no single treatment is optimal for all such lesions (27), multiple surgical approaches have been developed and various reconstructive procedures have been devised to allow more extensive resections. The two main surgical approaches are frontolateral partial laryngectomy and hemilaryngectomy.

Frontolateral Laryngectomy.—This procedure is used to treat vocal cord tumors that approach or involve the anterior commissure but do not cause vocal cord fixation. During surgery, a vertical segment of the thyroid cartilage is excised, and one vocal cord, the laryngeal ventricle and false cord, the anterior commissure, and a small anterior portion of the contralateral cord are removed (Fig 6). For repair, the mucosa on the contralateral side is sutured to the external perichondrium to completely resurface that side of the larynx. The side that underwent the major resection may be left open to await the formation of granular tissue (28).

CT scans obtained after vertical partial laryngectomy show three different radiologic hallmarks at the glottic level. First, there is a vertical defect in the thyroid lamina, which often appears with an irregular sclerotic border (29). The amount of thyroid cartilage resected varies according to the type of vertical partial laryngectomy performed. Second, the arytenoid cartilage on the involved side may or may not be depicted, depending on the surgical technique used; however, it is always preserved on the normal side. Last, the excised true vocal cord and a small anterior portion of the contralateral cord are replaced by dense scar tissue, which extends from the contralateral thyroid cartilage to the ipsilateral arytenoid area. This scar tissue, which is called pseudocord, may appear thick and irregular, with an absence of normal paraglottic fat. Because the resection is unilateral, the neovestibule is usually tilted toward the side of the major excision. In addition, CT scans obtained at the supraglottic level show less fat than is normally found in the preepiglottic space, no aryepiglottic fold, and an asymmetric neovestibule (Fig 7). The subglottic larynx remains normal in appearance (30).

Hemilaryngectomy.—Hemilaryngectomy is indicated for treatment of vocal cord tumors in which there is no fixation but in which the posterior extension is sufficient to require resection of the arytenoid cartilage (31). The procedure is contraindicated in the presence of anterior extension to more than the anterior third of the contralateral true vocal cord, lateral extension beyond the ventricle, or inferior extension to the subglottic larynx.

The exact extent of the resection depends on the individual tumor extension. However, the resection usually encompasses the same structures that are resected in a frontolateral partial laryngectomy, as well as the mucosa from the aryepiglottic fold to the upper border of the cricoid cartilage, the arytenoid cartilage, and the ipsilateral thyroid lamina.

A variety of reconstruction techniques have been developed in which various materials are used (eg, perichondrium, muscle, mucosa, and skin flaps; grafts; and prostheses).

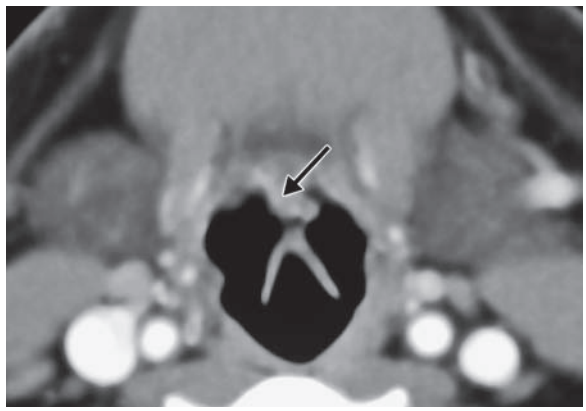


Figure 8. Epiglottic lesion of the free edge in a 53-year-old man. The lesion was initially detected at laryngoscopy. Presurgical CT scan shows a 0.5-mm lesion involving the glossoepiglottic fold (arrow). The preepiglottic fat, paraglottic fat, and false and true vocal cords (not shown) appeared normal.

Horizontal Laryngectomy

The horizontal surgical approaches most frequently used for treating laryngeal carcinomas are supraglottic laryngectomy and supracricoid laryngectomy.

Supraglottic Laryngectomy.—This approach usually is used to treat supraglottic carcinomas in which there is normal vocal cord mobility and no ventricular involvement (Fig 8) (32). Contraindications to supraglottic laryngectomy include tumor extension into the glottis or impairment of cord mobility; invasion of the thyroid cartilage, cricoid cartilage, or postcricoid area; extension to the base of the tongue; and involvement of the apex of the piriform sinus.

The supraglottic larynx comprises the epiglottis, the aryepiglottic folds, the false vocal cords, and the ventricle. A standard supraglottic laryngectomy involves the removal of these structures plus the upper third of the thyroid cartilage and the thyrohyoid membrane. The structures that usually remain intact after this type of resection include the true vocal cords, both arytenoid cartilages, the lower part of the thyroid cartilage, and the cricoid cartilage (Fig 9). The superior margin of the remaining thyroid cartilage is pulled up and attached to the hyoid bone in a reconstructive technique called thyrohyoidopexy (33).

Postsurgical CT images obtained at the supraglottic level after this procedure depict a dilated air-filled cavity. Because the thyroid cartilage was pulled upward for thyrohyoidopexy, the larynx is shortened, and the hyoid bone and remaining thyroid cartilage are visible in the same imaging plane. Redundant mucosa usually covers the arytenoid cartilages, and the glottic and subglottic structures appear normal (Fig 10).

Two variants of this surgical procedure may be applied on the basis of tumor extension: An extended supraglottic laryngectomy is performed for advanced-stage tumors and includes the additional resection of one arytenoid cartilage, the base of the tongue (Fig 11), or the piriform sinus (34). A three-quarters laryngectomy is performed

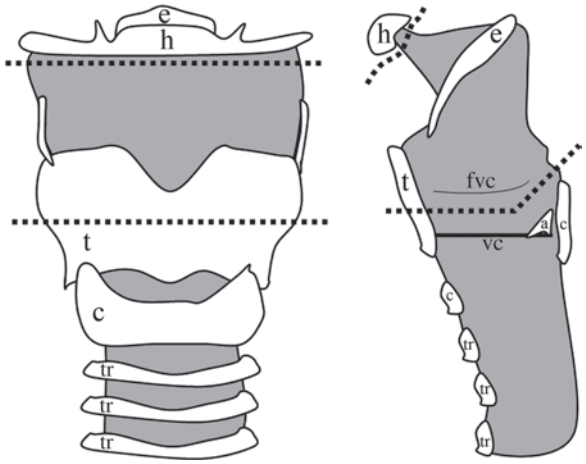
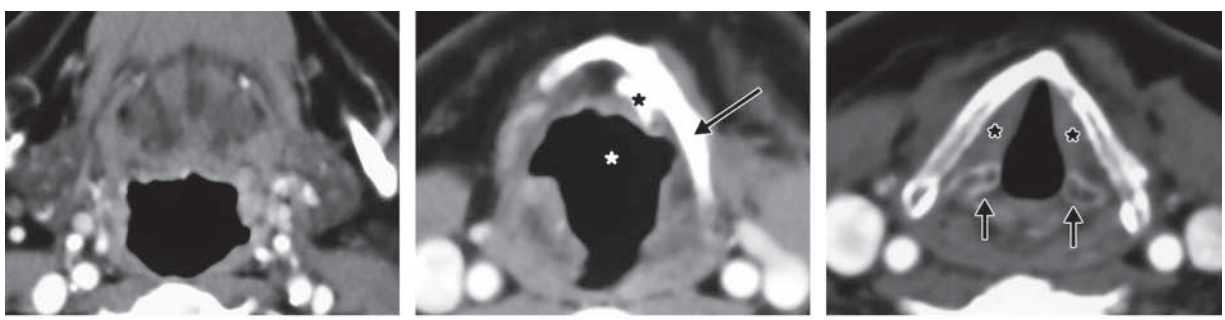
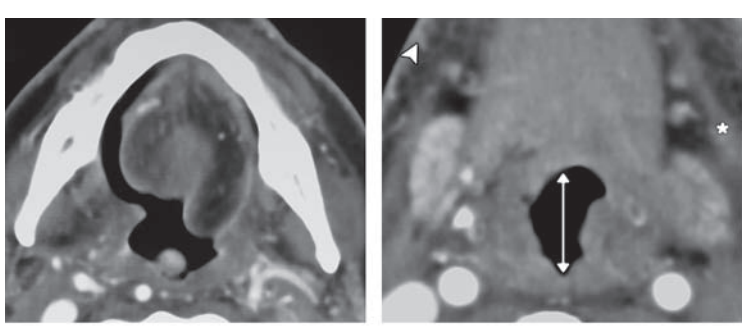


Figure 9. Frontal and lateral schematic views show the structures excised (area between dotted lines) in horizontal supraglottic laryngectomy: the epiglottis *(e)*, aryepiglottic folds, false vocal cords *(fvc)*, ventricle, and upper third of the thyroid cartilage *(t)*. *a* = arytenoid cartilage, *c* = cricoid cartilage, *h* = hyoid bone, *tr* = tracheal ring, *vc* = vocal cord.



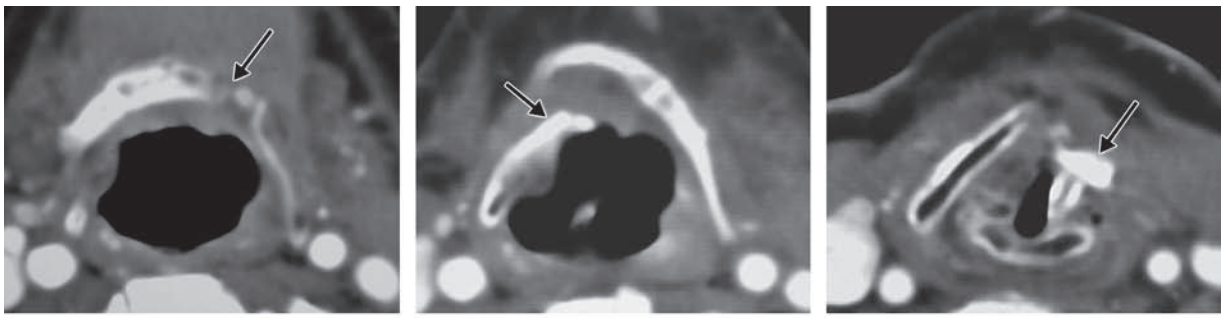
a. **b.** **c.**

Figure 10. Postsurgical CT scans obtained in a 54-year-old man (same patient as in Fig 8) 1 year after a horizontal supraglottic laryngectomy. **(a)** Axial image at the level of the base of the tongue shows the absence of the epiglottis. **(b)** Axial image at the level of the hyoid bone shows the absence of preepiglottic fat and asymmetry of the neovestibule (white ∗). The hyoid bone (arrow) overlaps with the remaining thyroid cartilage (black ∗). **(c)** Axial image at the level of the glottis shows normal true vocal cords (∗) and arytenoid cartilages (arrows).



a. **b.**

Figure 11. Postsurgical CT scans obtained in a 62-year-old man 1 year after an extended horizontal supraglottic laryngectomy for a supraglottic epidermoid carcinoma that extended superiorly to the left portion of the base of the tongue and inferiorly to the preepiglottic and paraglottic fat, epiglottis, valleculae, aryepiglottic folds, and false vocal cords. The true vocal cords were spared. **(a)** Axial image at the level of the oral cavity shows a remnant of the base of the tongue, with fat replacement of the left part of the tongue. **(b)** Axial image at the supraglottic level shows the absence of the hyoid bone and epiglottis and an irregular, asymmetric neolarynx (arrow), with thickening of the subcutaneous fat (arrowhead). Note that in this case the hyoid bone was excised because of its proximity to the tumor. The platysma muscle (∗) is enlarged because of radiation therapy.



a. b. c.

Figure 12. Postsurgical CT scans obtained 1 year after a three-quarters laryngectomy in a 67-year-old man with dysphonia secondary to a tumor involving the left half of the larynx from the aryepiglottic fold to the true vocal cord without cord fixation. The anterior commissure also was affected, but the right true vocal cord was normal. **(a)** Axial image at the level of the hyoid bone shows absence of the free edge of the epiglottis and a normal, irregularly shaped neovestibule. The small radiolucent spots in the hyoid bone (arrow) represent pexis attachment sites. **(b)** Axial image at a slightly lower level shows the hyoid bone in apposition to the thyroid cartilage remnant (arrow). **(c)** Axial image at the level of the glottis shows a left thyroid cartilage flap (arrow) that was created to facilitate phonation and avoid aspiration. The left true vocal cord is absent. The right-sided glottic structures are normal.

when a supraglottic tumor extends to the glottis on one side, with no evidence of either vocal cord fixation or thyroid cartilage invasion at CT. With this technique, the ipsilateral true vocal cord and arytenoid cartilage are resected in addition to the structures normally resected in supraglottic laryngectomy (Fig 12).

Supracricoid Laryngectomy.—Supracricoid laryngectomy is a partial surgical procedure that is used to treat selected supraglottic, glottic, or transglottic carcinomas that are not amenable to conventional partial laryngectomy. This type of surgery is a useful alternative to total laryngectomy.

Contraindications to supracricoid laryngectomy are inferior extension to the subglottic larynx, immobile arytenoid cartilage, and invasion of the valleculae or the base of the tongue. In addition, massive invasion of the preepiglottic space is a contraindication to supracricoid laryngectomy with cricohyoidopexy. Even slight anterior extension into the preepiglottic space is a contraindication to supracricoid laryngectomy with cricohyoidoepiglottopexy (35).

Supracricoid laryngectomy involves a sleeve-like resection of the laryngeal structures from the cricoid cartilage to the hyoid bone, including the entire thyroid cartilage and paraglottic space, vocal cords, ventricle, false vocal cords, and anterior commissure. At least one but preferably both arytenoid cartilages are preserved with intact innervation and mobility (36).

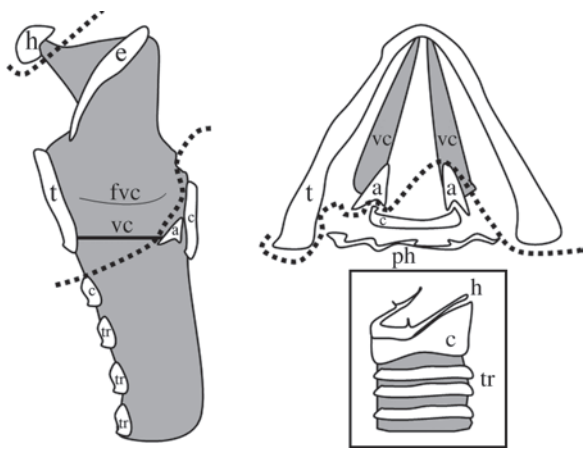
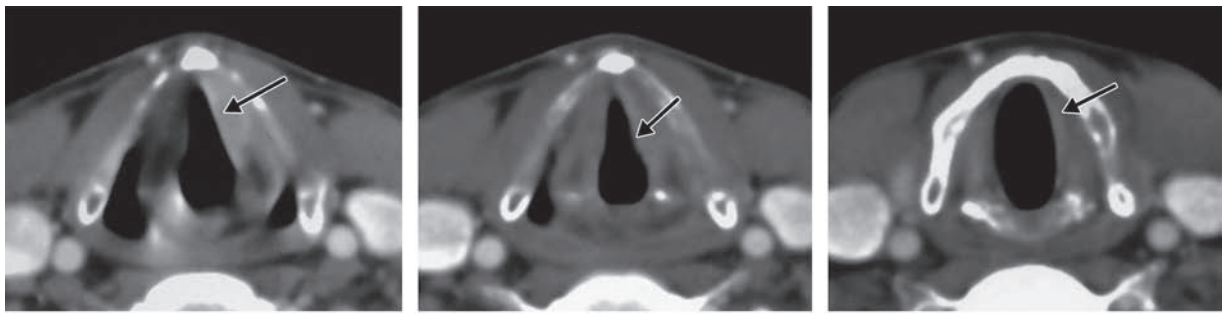


Figure 13. Left and top right: Lateral and axial schematics show the structures resected (area inside dotted lines) in supracricoid laryngectomy with cricohyoidopexy. All structures between the cricoid cartilage *(c)* and the hyoid bone *(h)* are resected, while at least one arytenoid cartilage *(a)* is spared. Box at bottom right: In cricohyoidopexy, the hyoid bone is sutured tightly to the cricoid cartilage to repair the large surgical defect. *e* = epiglottis, *fvc* = false vocal cord, *ph* = pharynx, *t* = thyroid cartilage, *tr* = tracheal ring, *vc* = vocal cord.



a. b. c.

Figure 14. Presurgical CT scans obtained in a 59-year-old man with dysphonia and a history of heavy smoking. **(a)** Axial image at the level of the aryepiglottic folds shows thickening of the anterior portion of the left aryepiglottic fold (arrow). **(b, c)** Axial images at successively lower levels show extension of the lesion to the ipsilateral false vocal cord (arrow in **b**) and the left true vocal cord (arrow in **c**). The lesion was subsequently diagnosed as an epidermoid carcinoma.

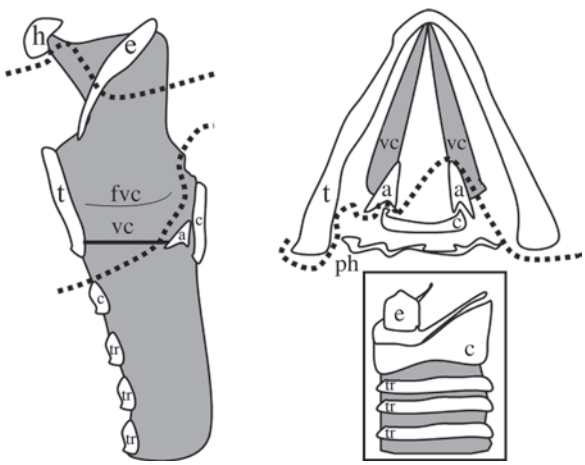
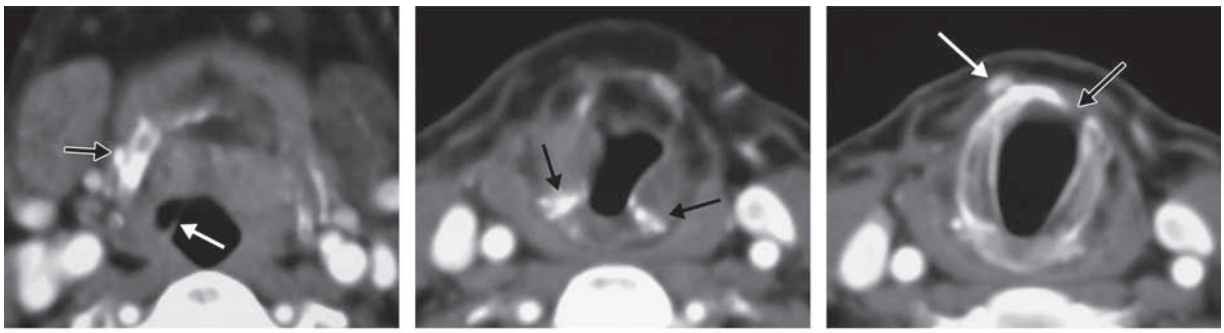


Figure 15. Left and top right: Lateral and axial schematics show the structures excised (area inside dotted lines) in supracricoid laryngectomy with cricohyoidoepiglottopexy. All laryngeal structures between the cricoid cartilage *(c)* and the hyoid bone *(h)* are resected, while the suprahyoid epiglottis *(e)* is spared. Box at bottom right: In subsequent cricohyoidoepiglottopexy, the larynx is reconstructed by suturing the hyoid bone and the suprahyoid epiglottis tightly to the cricoid cartilage. *a* = arytenoid cartilage, *fvc* = false vocal cord, *ph* = pharynx, *t* = thyroid cartilage, *tr* = tracheal ring, *vc* = vocal cord.

One of two reconstruction techniques may be used in supracricoid laryngectomy: cricohyoidopexy or cricohyoidoepiglottopexy. Supracricoid laryngectomy with cricohyoidopexy is performed to treat supraglottic carcinomas involving the preepiglottic space, paraglottic space, or thyroid cartilage. In this procedure, the paraglottic, epiglottic, and preepiglottic spaces and the entire thyroid cartilage are resected. The resultant large laryngeal defect is repaired by suturing the hyoid bone tightly to the cricoid cartilage (Fig 13) (37).

Supracricoid laryngectomy with cricohyoidoepiglottopexy is performed to treat early-stage carcinomas of the anterior commissure, tumors involving both vocal cords, and tumors of an entire vocal cord with impaired mobility (Fig 14). The epiglottis, which is resected in supracricoid laryngectomy with cricohyoidopexy, is spared in supracricoid laryngectomy with cricohyoidoepiglottopexy. In the latter procedure, the larynx is reconstructed by suturing the hyoid bone and the suprahyoid epiglottis closely to the cricoid cartilage (Fig 15) (38).

CT scans obtained after supracricoid laryngectomy with cricohyoidoepiglottopexy show a total or near total absence of the thyroid cartilage (the inferior cornu may have been spared to avoid damage to the recurrent laryngeal nerve). The cricoid cartilage, hyoid bone, and suprahyoid epiglottis appear to be attached at the midline in the same imaging plane because of shortening of the larynx. At least one cricoarytenoid joint is visible. The gap left by surgical resection of the false and true vocal cords is replaced by soft tissue that appears thickened, and there is redundant tissue



a. b. c.

Figure 16. Follow-up CT scans obtained in a 60-year-old man (same patient as Fig 14) 1 year after supracricoid laryngectomy with cricohyoidoepiglottopexy. **(a)** Axial image at the level of the hyoid bone (black arrow) shows attachment of the free edge of the epiglottis to lingual tissue (white arrow). **(b)** Axial image at a lower level than **a** depicts a neovestibule with an irregularly shaped lumen. Both arytenoid cartilages are visible (arrows), but the thyroid cartilage is absent. **(c)** Axial image at the level of the cricoid cartilage shows the right-sided pexis of the cricoid cartilage (white arrow) to the hyoid bone. The subglottic lumen has a regular contour outlined by a thin mucosa. The small notch in the left border of the cricoid cartilage (black arrow) is a result of surgical manipulation.

around the arytenoid cartilage. The surgically constructed neoglottis is asymmetric and has a transverse orientation because of the formation of the pseudocord (Fig 16). Postsurgical CT findings in supracricoid laryngectomy with cricohyoidopexy are similar to these, the only difference being the absence of the epiglottis.

Near Total Laryngectomy

Near total laryngectomy is a voice-preserving surgical option that may be used in cases of advanced-stage unilateral laryngeal carcinoma for which partial laryngectomy is contraindicated. Conventionally, such lesions would be treated with total laryngectomy.

In near total laryngectomy, one side of the larynx and part of the contralateral vocal cord—usually the anterior portion—are removed. The site of resection extends posteriorly to the midline. Inferiorly, the resected structures include the ipsilateral cricoid cartilage, the thyroid lobe, and, if necessary, one or more of the upper tracheal rings. Superiorly, the entire preepiglottic space, the epiglottis, the hyoid bone, and the valleculae may be excised (39).

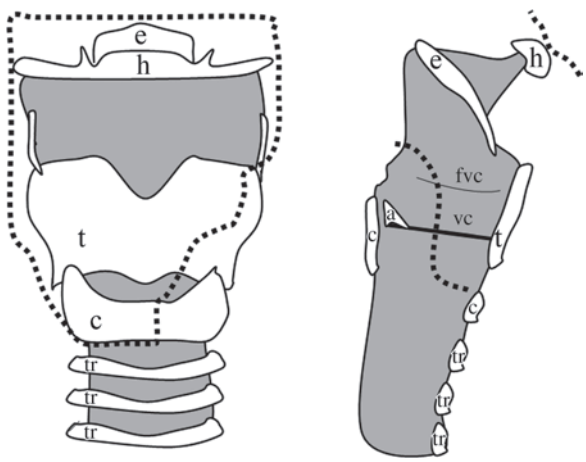
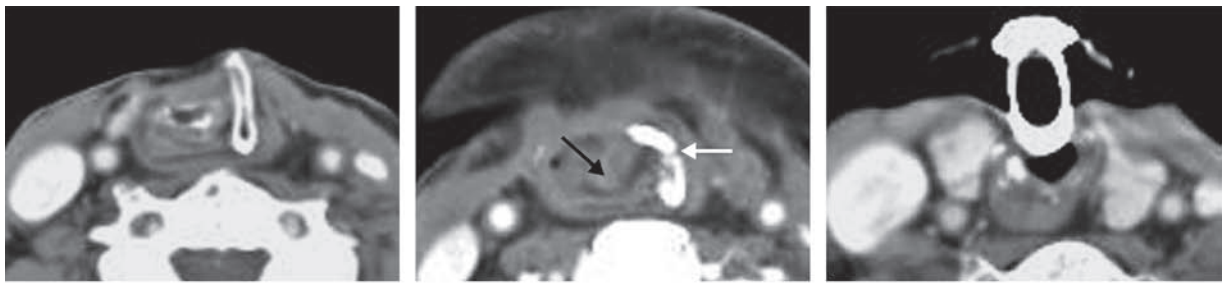


Figure 17. Frontal and lateral schematics show the structures excised (area between dotted lines) in near total laryngectomy. The most severely affected half of the larynx is completely removed. A portion of the less severely affected half, including part of the thyroid lamina *(t)*, the arytenoid cartilage *(a)*, and part of the vocal cord *(vc)*, is preserved. *c* = cricoid cartilage, *e* = epiglottis, *fvc* = false vocal cord, *h* = hyoid bone, *tr* = tracheal ring.

A segment of the contralateral (uninvolved) side of the larynx is preserved, including the recurrent laryngeal nerve, part of the thyroid lamina, the entire arytenoid cartilage, and a portion of the thyroarytenoid muscle (Fig 17).



a. b. c.

Figure 18. Follow-up CT scans obtained in a 57-year-old man after a near total laryngectomy for a right transglottic tumor with subglottic extension. **(a)** Axial image at the level of the neoglottis (dynamic phonatory shunt) shows remnants of the left laryngeal cartilages (parts of the thyroid lamina and the arytenoid cartilage). **(b)** Axial image at a slightly lower level than **a** shows the neolarynx as several concentric soft-tissue layers (black arrow) at the midline. Part of the left cricoid cartilage (white arrow) also is depicted. **(c)** Axial image at a lower level than **b** shows the absence of the thyroid isthmus. A tracheostomy tube is clearly visible in the lower part of the neck.

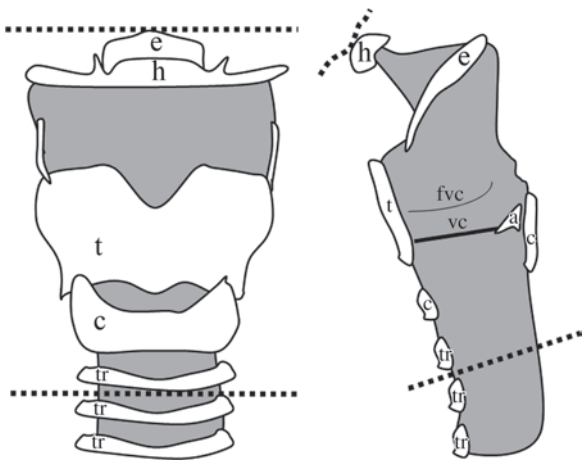


Figure 19. Frontal and lateral schematics show the structures excised (area between dotted lines) in total laryngectomy. The entire larynx from the hyoid bone *(h)* and epiglottis *(e)* to the cricoid cartilage *(c)*, including the arytenoid (*a*) and thyroid *(t)* cartilages and the false *(fvc)* and true *(vc)* vocal cords, and one or more upper tracheal rings *(tr)* are removed.

From these structures, a mucosa-lined tube is constructed that connects the trachea to the pharynx and serves as a dynamic phonatory shunt. Breathing is maintained through a permanent tracheostomy, which must be occluded during expiration to allow vocal production (40).

Teaching Point

On radiologic images, the dynamic phonatory shunt appears as a circumferential soft-tissue structure in the place of the normal larynx. Remnants of the larynx-supporting cartilages and parts of at least one thyroid lamina, one arytenoid cartilage, and the cricoid cartilage also can be seen. Part of the thyroid gland is absent. Perhaps the most obvious hallmark of this type of surgery is the tracheostomy tube in the lower part of the neck (Fig 18).

Total Laryngectomy

Total laryngectomy is indicated for treatment of extensive laryngeal carcinomas that have invaded the laryngeal cartilages or extend beneath the glottis to the cricoid cartilage. This procedure also is used for salvage after failed radiation therapy or in cases of local recurrence after partial laryngectomy. Other indications include certain piriform sinus carcinomas and chondroradionecrosis. Contraindications to this type of surgery are metastasis and synchronous tumor.

Total laryngectomy entails the removal of all the endolaryngeal structures (the epiglottis, aryepiglottic folds, true and false vocal cords, and subglottic larynx) and the entire laryngeal framework (the hyoid bone, the thyroid cartilage, both arytenoid cartilages, the cricoid cartilage, and one or more tracheal rings) (Fig 19). The

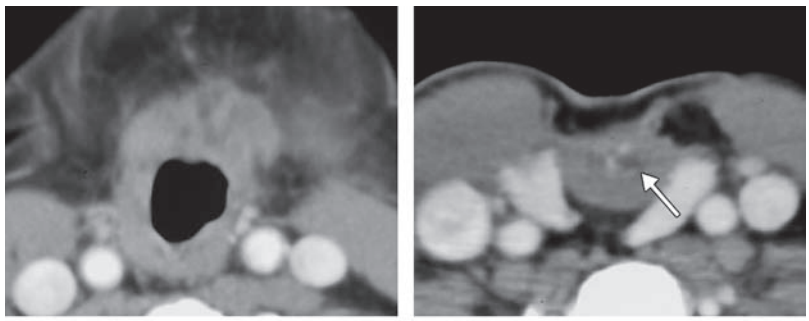


Figure 20. Follow-up CT scans in a 53-year-old man 1 year after total laryngectomy. **(a)** Axial image at the supraglottic level shows a dilated air-filled cavity. **(b)** Axial image at the glottic through subglottic levels shows the absence of the laryngeal framework and soft tissues and of the thyroid isthmus. The neopharynx is depicted as a concentrically layered soft-tissue structure (arrow).

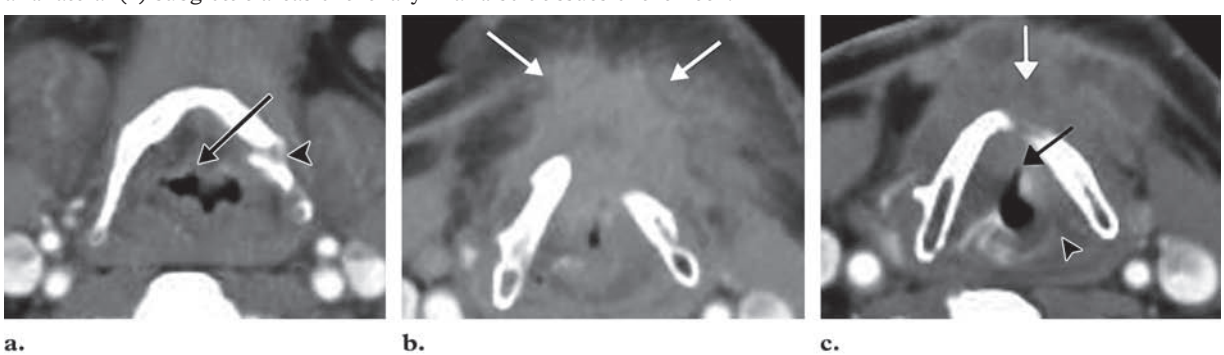


Figure 21. Follow-up CT scans in a 49-year-old man 2 years after a left vertical hemilaryngectomy for an epidermoid carcinoma of the laryngeal glottis. **(a)** Axial image at the level of the hyoid bone shows increased attenuation of the preepiglottic fat (arrow). Note the apposition of the residual left thyroid lamina to the hyoid bone (arrowhead). **(b)** Image at the inferior supraglottic level shows a mass with extralaryngeal spread to the anterior soft tissues of the neck (arrows). **(c)** Image at the level of the glottis shows downward extension of the mass to the anterior glottic area (black arrow) and the anterior soft tissues of the neck (white arrow). Note the absence of the previously resected left arytenoid cartilage (arrowhead). **(d)** Image at a lower level than **a–c** shows extension of the lesion to the anterior (arrow) and lateral (*) subglottic areas of the larynx and soft tissues of the neck.

resected portion of the thyroid gland varies. In reconstruction, the pharyngeal defect is closed with overlapping layers of soft tissue and muscle (hypopharyngeal mucosa, pharyngeal inferior constrictor musculature) to form a conical neopharynx that extends from the base of the tongue to the cervical esophagus.

Teaching Point

Postsurgical CT scans show the absence of all laryngeal structures and only a remnant of the thyroid gland. On axial images, the neopharynx, with its concentric soft-tissue layers, appears centered in the neck, where the normal larynx would be. In the absence of compression by the cartilaginous supporting structures and the thyroid gland, the usually flat esophagus appears round (Fig 20) (41).

Recurrent Disease and Second Malignancies

Despite the many treatment options available, local failure is a significant problem (42). Locally persistent or recurrent disease contributes to the majority of early deaths (deaths within 3 years after diagnosis) from head and neck cancers (43) (Fig 21). In addition to local tumor persistence and recurrence, the development of second primary tumors (head and neck, lung, and esophageal cancers) is a main cause of mortality among patients who survive for more than 3 years (44,45). At one time, it was commonly assumed that second primary tumors developed independently of first primary tumors, after widespread epithelial exposure to carcinogens. However, the results of recent studies suggest that at least some second primary tumors arise from a single clonal cell population (46).

Physical examination and endoscopy are the key modalities used for surveillance. In addition, CT is routinely used to rule out persistent or recurrent local-regional disease and to screen for second malignancies.

Summary

Various partial and total laryngectomy procedures may be used in the surgical treatment of laryngeal cancer, and the resultant anatomic changes may make postsurgical image interpretation difficult. To achieve an accurate interpretation, radiologists must understand how each surgical technique affects the imaging results. Because CT is often used in follow-up imaging evaluations, a familiarity with the CT appearances that are characteristic of postsurgical anatomic changes and of persistent or recurrent tumors is particularly important.

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CT Findings after Laryngectomy

Concepción Ferreiro-Argüelles, MD, et al

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The optimal treatment for cancers of the larynx is a subject of controversy. Treatment decisions depend on several factors, including the tumor location, the disease stage, and the patient's needs and preferences. Various treatment modalities may be used.

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Whereas total laryngectomy results in a complete loss of vocal function, partial laryngectomy involves the preservation of a portion of the larynx so that vocal sounds can be produced. In addition, respiration is preserved (usually without a permanent tracheostomy), and swallowing is possible without aspiration.

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When reading postsurgical CT scans, radiologists should take into account the type of resection performed, irregularities in the shape of the remaining soft tissues of the larynx, and the complete or partial absence of adjacent cartilaginous structures. The surgical reconstruction technique may be identified by considering the relationship of the remaining cartilages to the hyoid bone.

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On radiologic images [obtained after a near total laryngectomy], the dynamic phonatory shunt appears as a circumferential soft-tissue structure in the place of the normal larynx. Remnants of the larynx-supporting cartilages and parts of at least one thyroid lamina, one arytenoid cartilage, and the cricoid cartilage also can be seen. Part of the thyroid gland is absent. Perhaps the most obvious hallmark of this type of surgery is the tracheostomy tube in the lower part of the neck.

Page 880

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