

### 3. Indications

#### 3.A. Glottic cancer

Tracheal autotransplantation allows for conservation laryngectomy for unilateral glottic tumors with arytenoid cartilage fixation and infraglottic tumor extension reaching the upper border of the cricoid cartilage, two major contraindications for all 'classical' conservation procedures. An extended hemilaryngectomy may be utilized for unilateral T2-T3 glottic cancers with posterior glottic extension greater than 5 mm but without extension into the ventricle. The resection can be extended towards the anterior third of the contralateral vocal fold for tumors reaching the anterior commissure (Fig. 5.36).

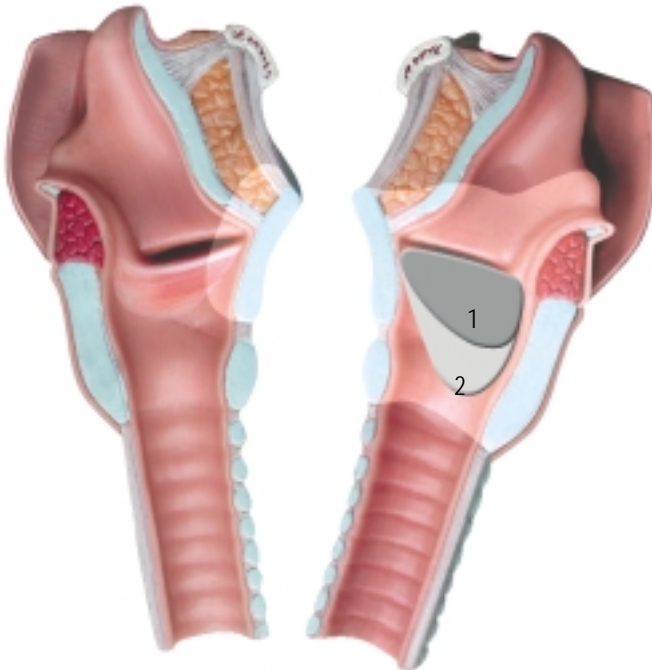


Figure 5.36. Extent of tumor extension.

1. Glottic tumor with subglottic extension. The tumor can reach the anterior commissure but the posterior midline and the supraglottis has to be free of any tumor.

2. This extensive subglottic tumor extension is an indication in non irradiated patients but is too risky in irradiation failures (submucosal tumor spread).

The unilateral glottic tumor with fixation of the vocal fold is a good indication for tracheal autotransplantation. Currently, these tumors are treated with radiotherapy with or without chemotherapy with an average chance for local control of about 50 %. Surgical treatment for the recurrent or persistent tumor means total laryngectomy. This treatment policy may change when a function and organ saving surgical procedure becomes available. For unilateral glottic tumors, tracheal autotransplantation allows for a resection with margins comparable to a total laryngectomy and with a predictable good function.

The unilateral T2, T3 glottic cancer (Fig. 5.37) forms an indication when all other partial laryngectomies (with inclusion of the supracricoid partial laryngectomy) are contraindicated:

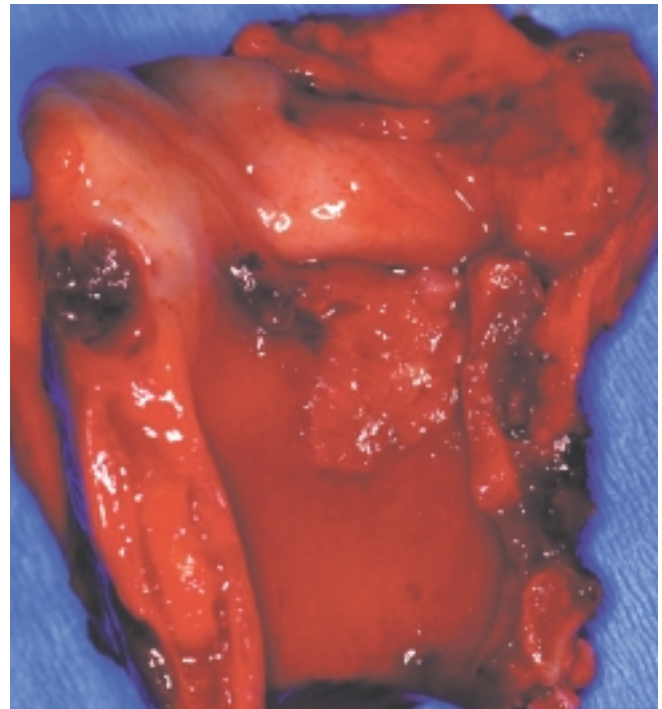
1. Tumors of the glottis with fixation of the arytenoid cartilage.
2. Tumors of the glottis with subglottic extent reaching the upper border of the cricoid cartilage or invading the cricoid cartilage.

Oncologic contraindications for a tracheal autotransplantation include the following:

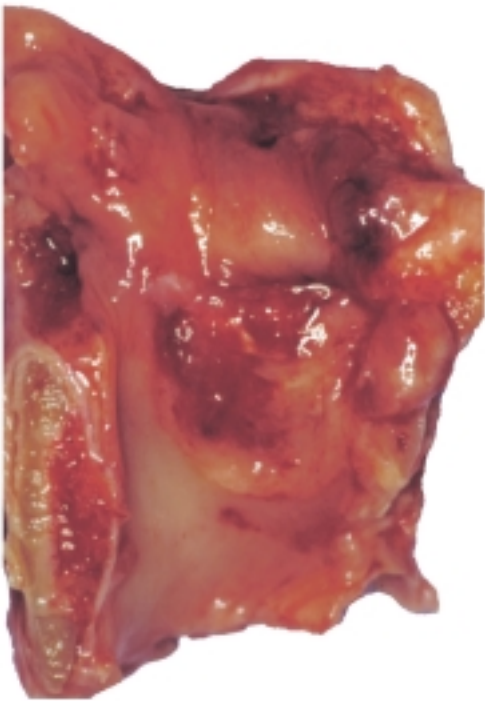
1. Tumors originating in the ventricle or the anterior commissure, since they have a propensity for early invasion of the preepiglottic space.
2. Tumors of the glottis invading the posterior commissure.
3. Bilateral mucosal invasion of the arytenoid cartilage.
4. Tumor involvement of both vocal folds.



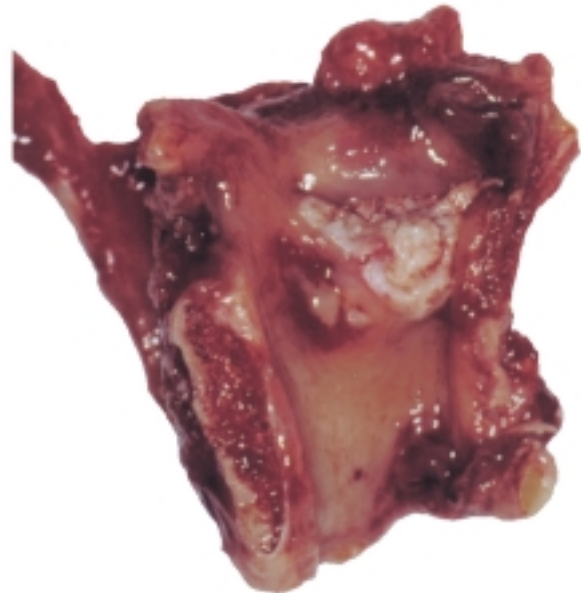
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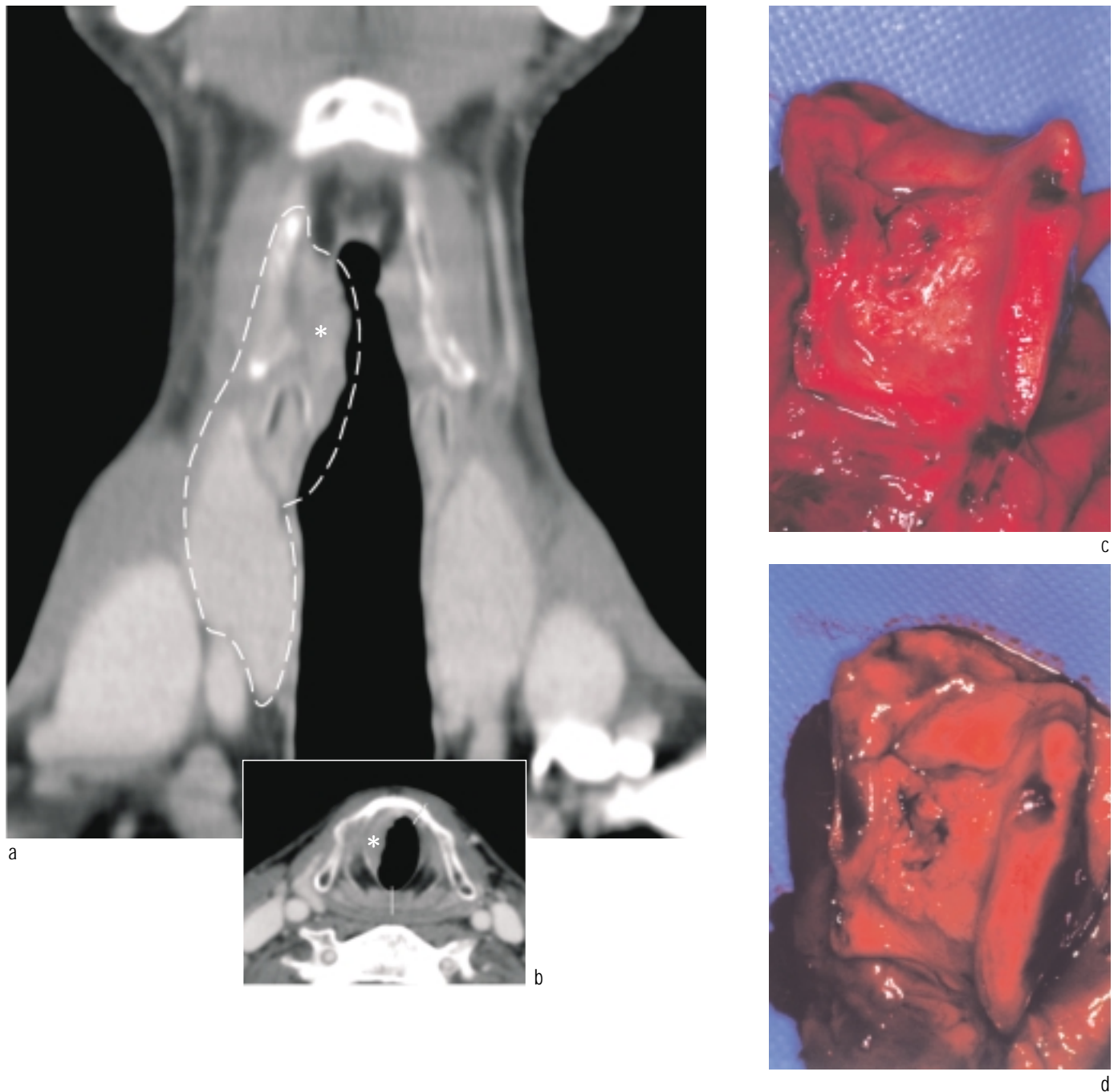
**Figure 5.37.** Resection specimen after extended hemilaryngectomy for T2-T3 glottic cancer.

**a.** Tumor of the vocal fold with posterior subglottic extension.

**b., c., d.** Tumor of the vocal fold with subglottic extension. The anterior commissure is included in the resection.

The tumor extension visible in a., b., c. and d. is suitable for extended hemilaryngectomy in both non-irradiated and irradiated cases.

The maximal amount of tumor extension allowed in non-irradiated cases is visible in Fig. 5.38.



**Figure 5.38.** Maximal amount of tumor resection.

**a.** Contrast-enhanced CT. Coronal reformatted view shows the tumor (star) with subglottic extension. Amount of resection is indicated. Ipsilateral thyroid gland and tracheoesophageal lymph nodes are removed.  
**b.** Axial CT scan at subglottic level shows the tumor

(star). Amount of resection is indicated.

**c.** Resection specimen. Anterior commissure is included in the resection.

**d.** Resection specimen. Posterior commissure is free of tumor.

After irradiation, the unilateral T2-T3 glottic cancer without extension to the ventricle and without extension to the posterior midline may be treated with this technique.

The different operative steps are summarized in Fig. 5.39, 5.40, 5.41, 5.42, 5.43, 5.44, 5.45 for a unilateral T2-3N0 glottic cancer at the right side.

Table 5.5.

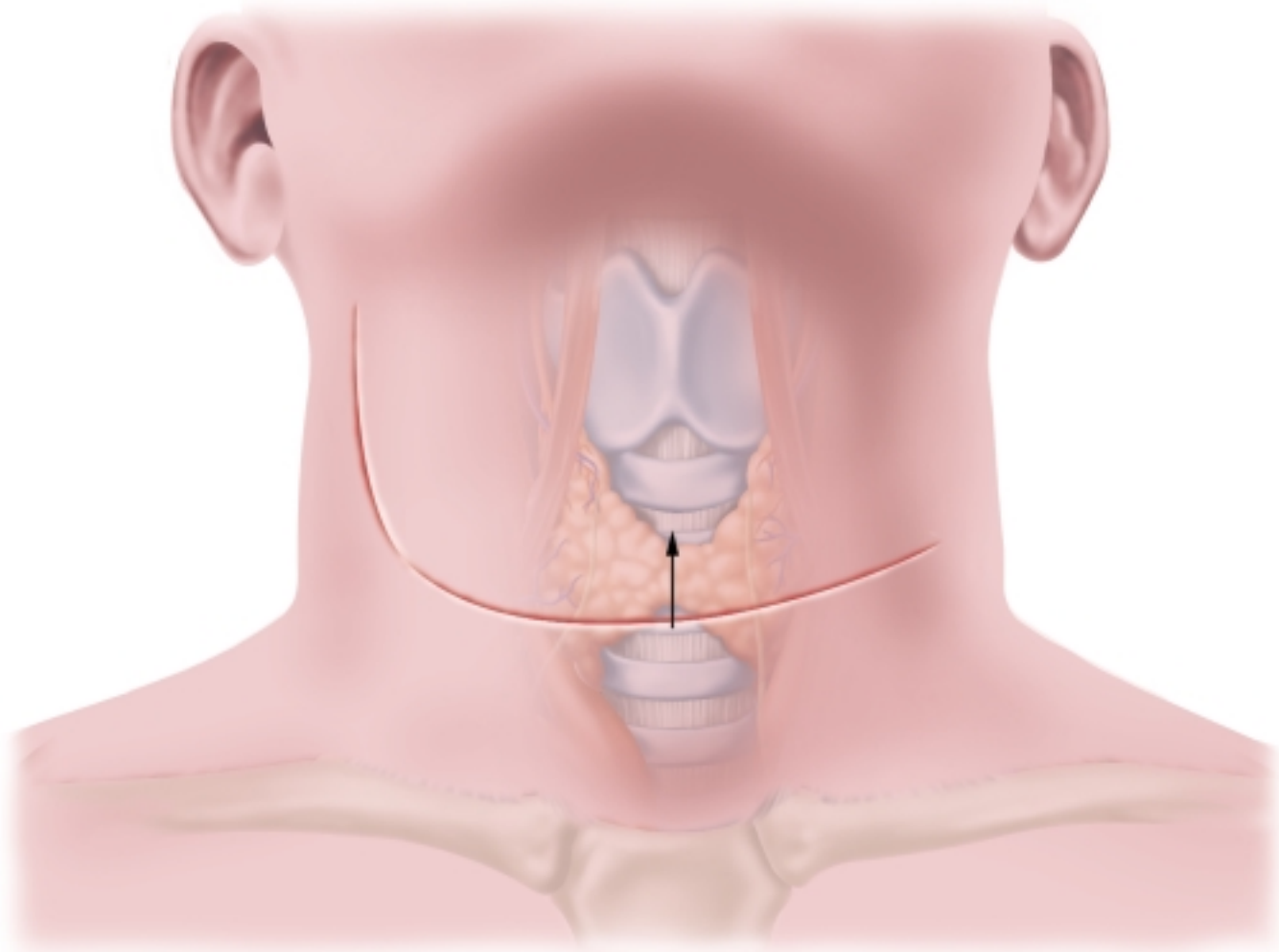
Tracheal autotransplantation-Indications glottic cancer

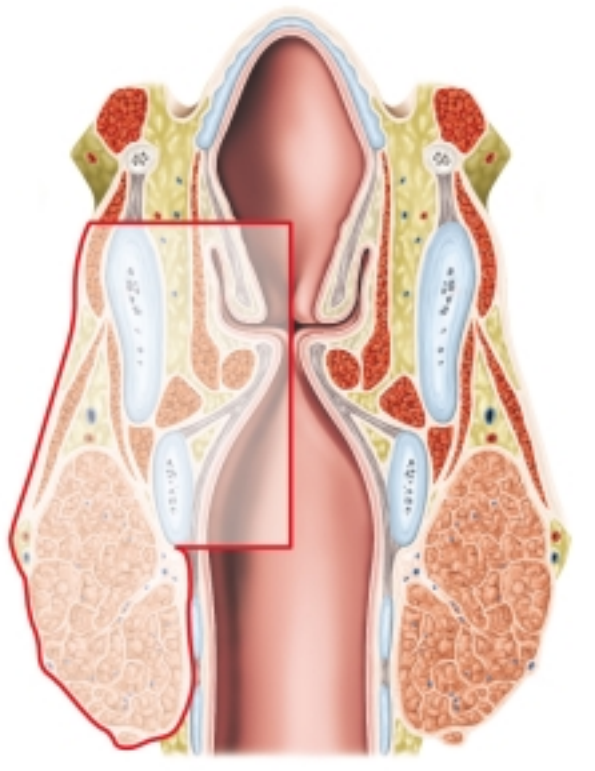
T2-T3 glottic cancer with unilateral localization

Contraindications: -Involvement of ventricle  
-Posterior commissure involvement  
-Involvement of both vocal folds

*Figure 5.39. Neck skin incision.*

*The incision is placed 2 to 3 cm above the sternal notch. After the first operation, the lower neck skin flap will be sutured to the first tracheal ring (arrow) without tension. The neck incision will be extended to the mastoid at the tumor side.*





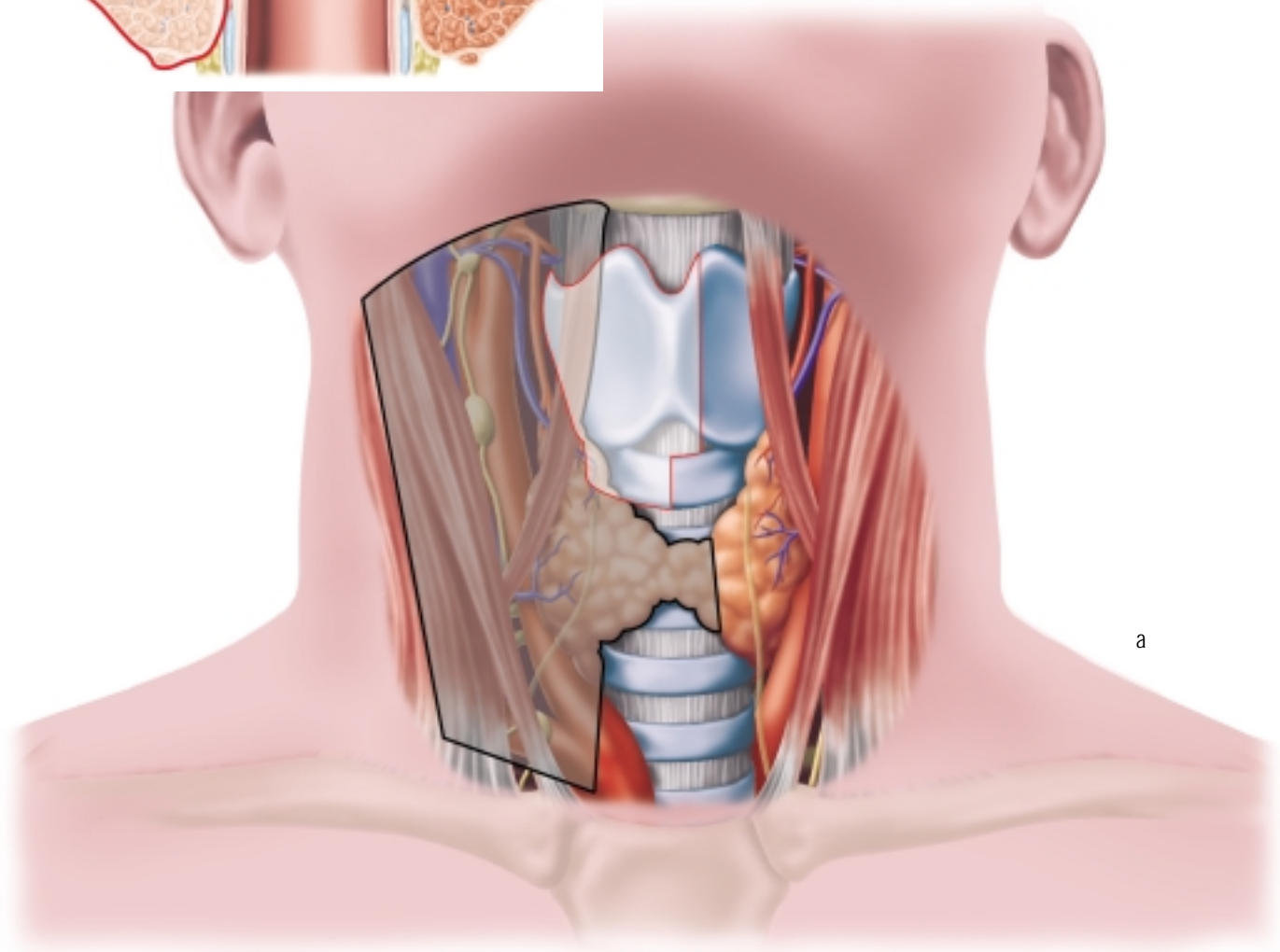
b

**Figure 5.40.**  
*Amount of resection for a unilateral T2-3N0 glottic cancer at the right side.*

*a. Overview. The amount of larynx included in the resection is indicated. One cm of the contralateral thyroid cartilage is included in the resection. An anterolateral (levels II, III, IV) neck dissection will be done. The ipsilateral thyroid gland, recurrent nerve, and tracheoesophageal lymph nodes will be removed.*

*b. Frontal section.*

a



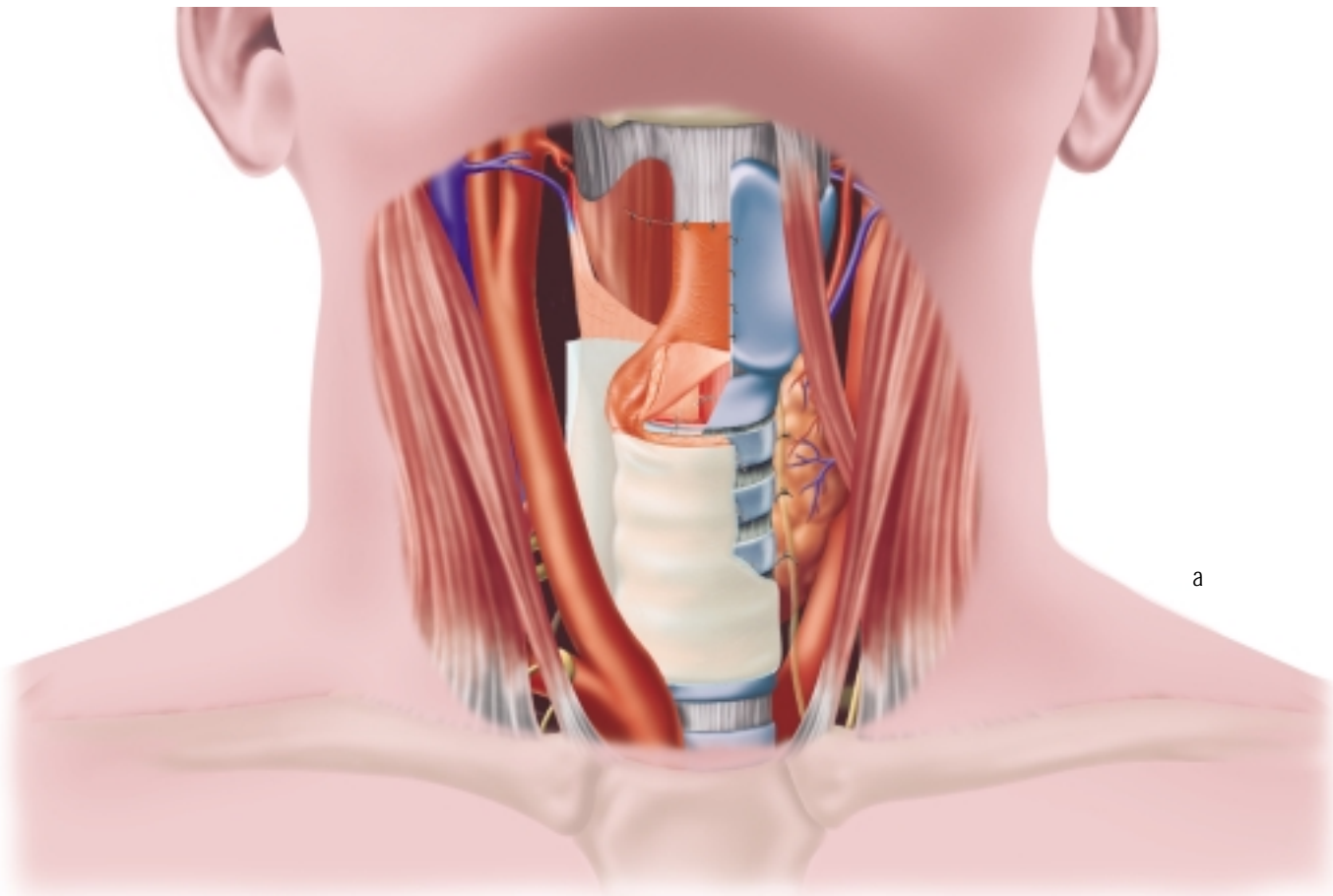
**Figure 5.41. First operation.**

**a.** Situation after tracheal wrapping, temporary larynx reconstruction, and suturing of the radial vessels to the superior thyroid vessels. The contralateral recurrent nerve is identified in the caudal neck. Full dissection of the contralateral recurrent nerve until it enters the larynx is not necessary. The contralateral thyroid lobe can be dissected from the trachea without danger for damage to the recurrent nerve.

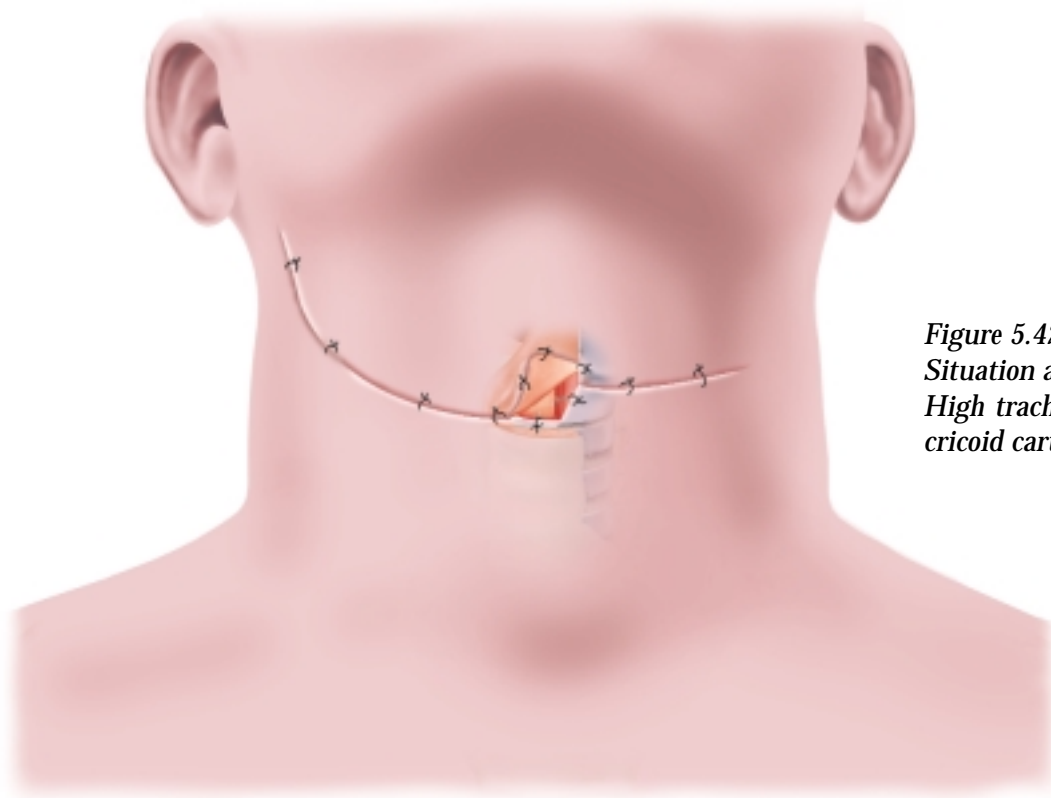
**b.** Radial forearm flap used for reconstruction. The fascial paddle measures 4 x 10 cm. The skin paddle measures 4 by 8 cm. Between 2.5 and 3 cm of the skin flap is included at the glottic level. The skin flap is somewhat larger than strictly needed and the excessive amount of skin paddle (bright area) can be desepithelialized during inset of the flap.



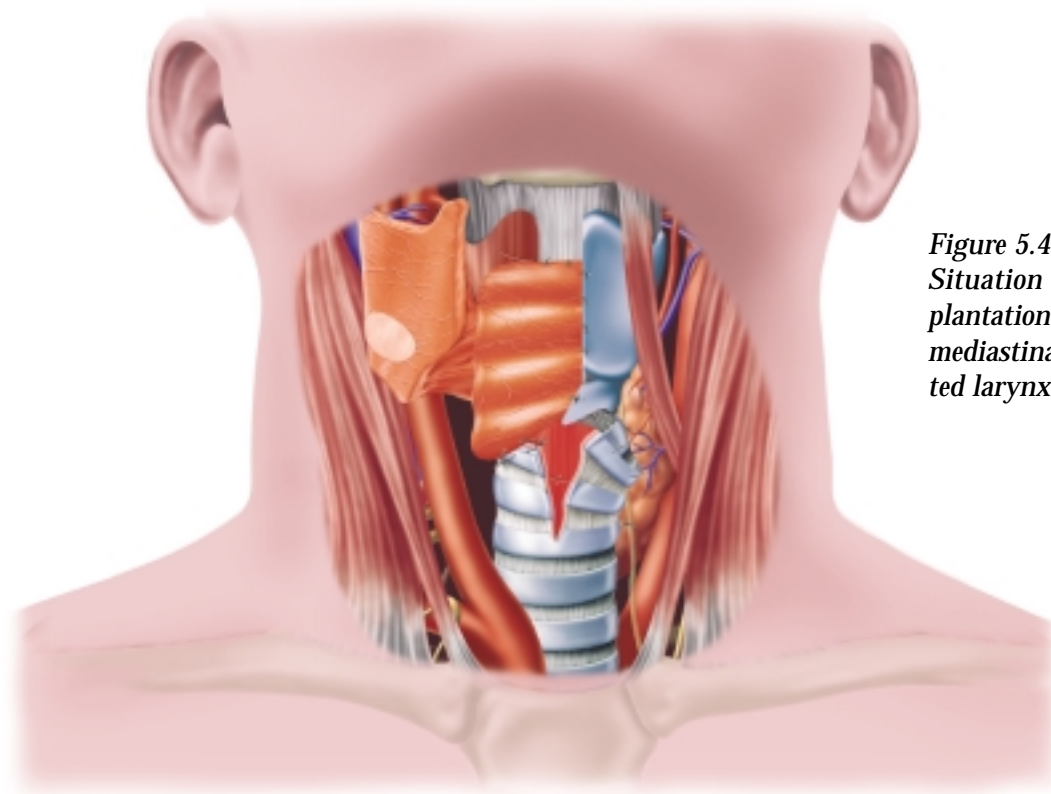
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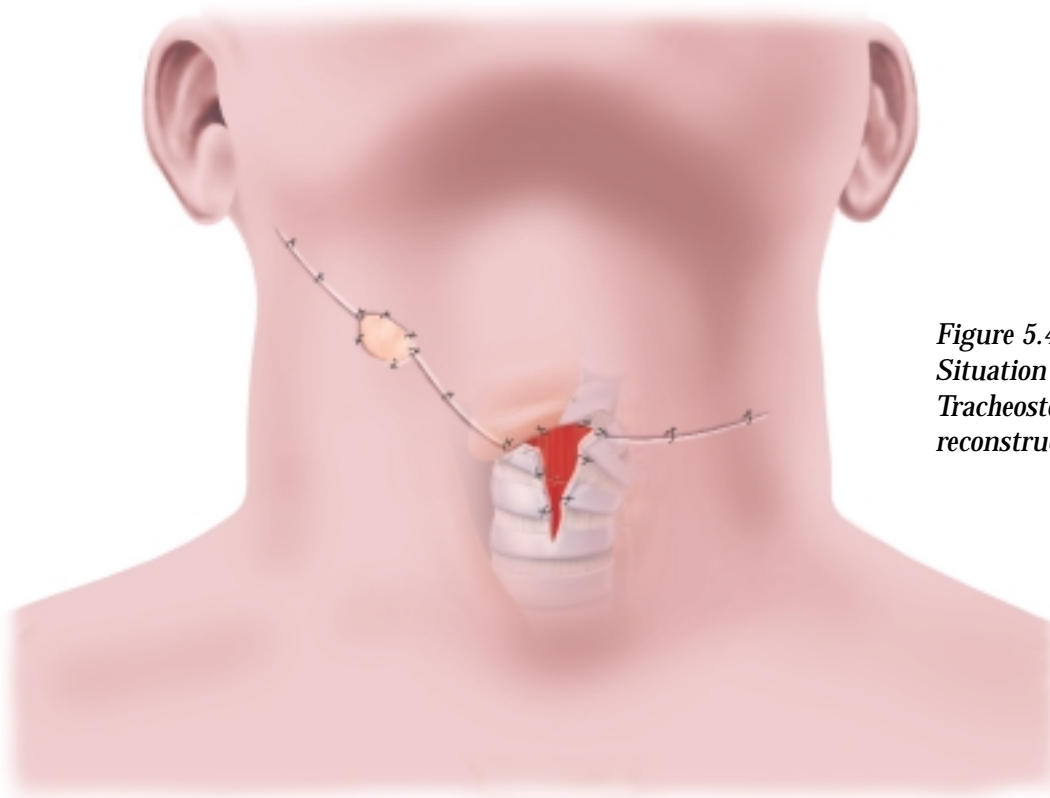
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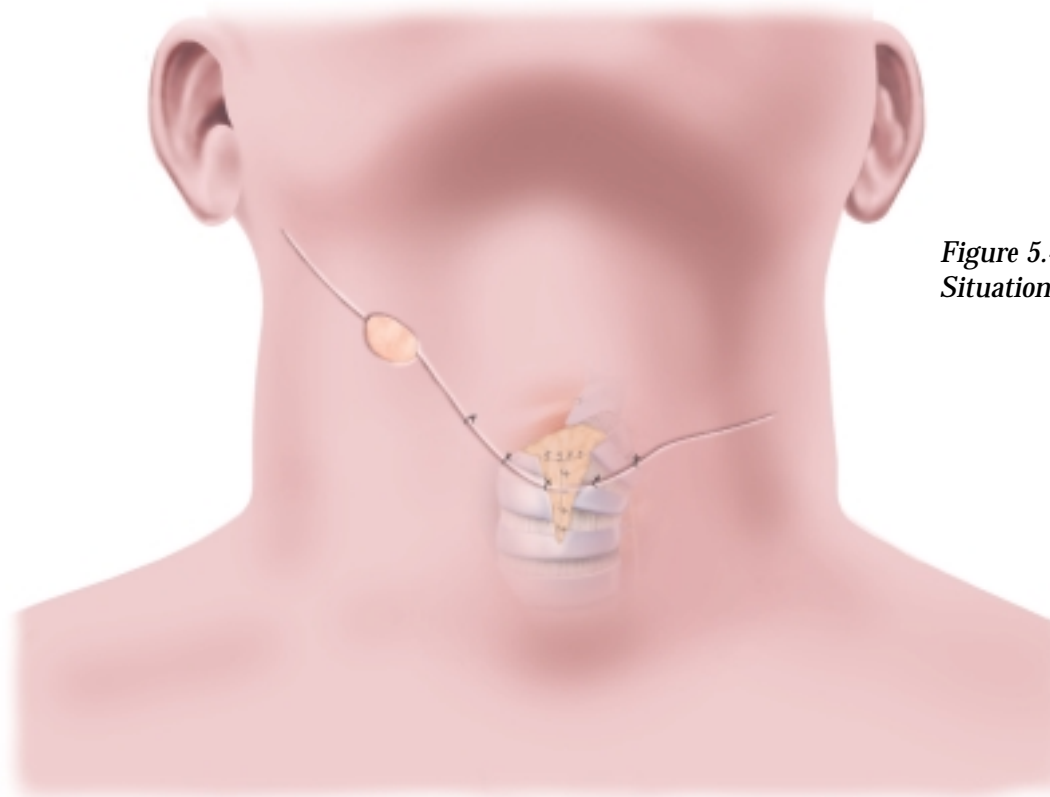
*Figure 5.42.*  
*Situation after first operation.*  
*High tracheostoma at the level of the*  
*cricoid cartilage.*



*Figure 5.43. Second operation.*  
*Situation after tracheal autotrans-*  
*plantation with anastomosis of the*  
*mediastinal trachea to the recon-*  
*structed larynx.*



*Figure 5.44.*  
*Situation after second operation.*  
*Tracheostoma immediately below the*  
*reconstructed larynx.*



*Figure 5.45.*  
*Situation after tracheostomy closure.*

## B. Hypopharyngeal cancer

Hypopharyngeal cancer can be an indication in very selected cases (Fig 5.46). Four patients in our series (initial and modified concept) were treated for hypopharyngeal cancers. Two patients were treated for a carcinoma and 2 patients were treated for a sarcoma (1 liposarcoma and 1 fibrosarcoma). The 2 carcinoma patients underwent postoperative irradiation; the 2 sarcoma patients were not irradiated. The 4 patients are free of tumor (2 to 6 years postoperatively) and all tracheostomies were closed.

**Figure 5.46. Hypopharyngeal cancer.**

**a. Indication for tracheal autotransplantation.**

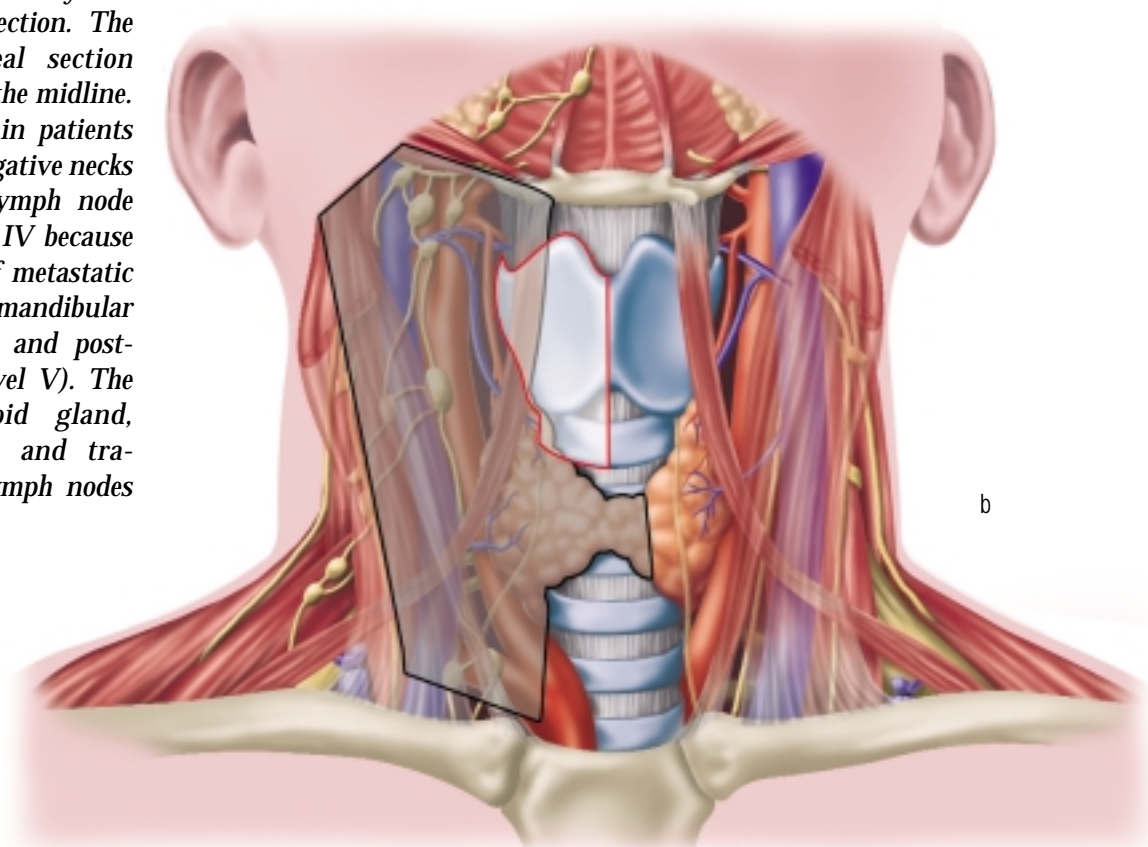
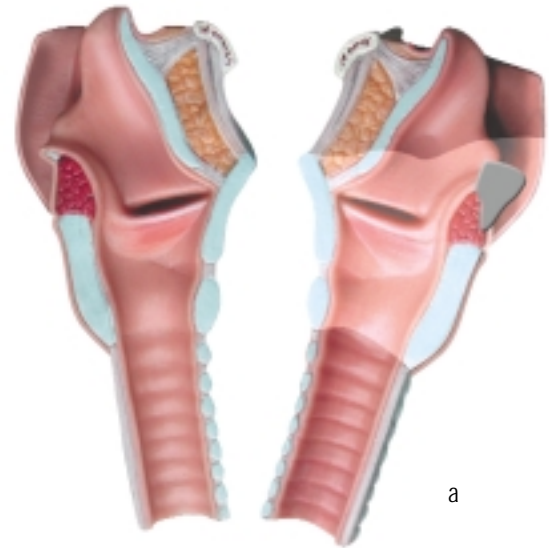
A small tumor of the pyriform sinus with involvement of the apex may be an indication for tracheal autotransplantation. The section margins are placed in the posterior and anterior commissure. The hypopharyngeal defect is closed primarily.

**b. Extend of resection.** The anterior laryngeal section line is located in the midline. Neck dissections in patients with clinically negative necks should include lymph node levels II, III, and IV because of the low risk of metastatic disease in the submandibular triangle (level I) and posterior triangle (level V). The ipsilateral thyroid gland, recurrent nerve, and tracheoesophageal lymph nodes will be removed.

**Table 5.6.**

**Tracheal autotransplantation-Indications hypopharynx**

- T2-3 pyriform sinus tumor with infiltration in apex
- Tumor not beyond the midline
- Primary closure of hypopharynx necessary



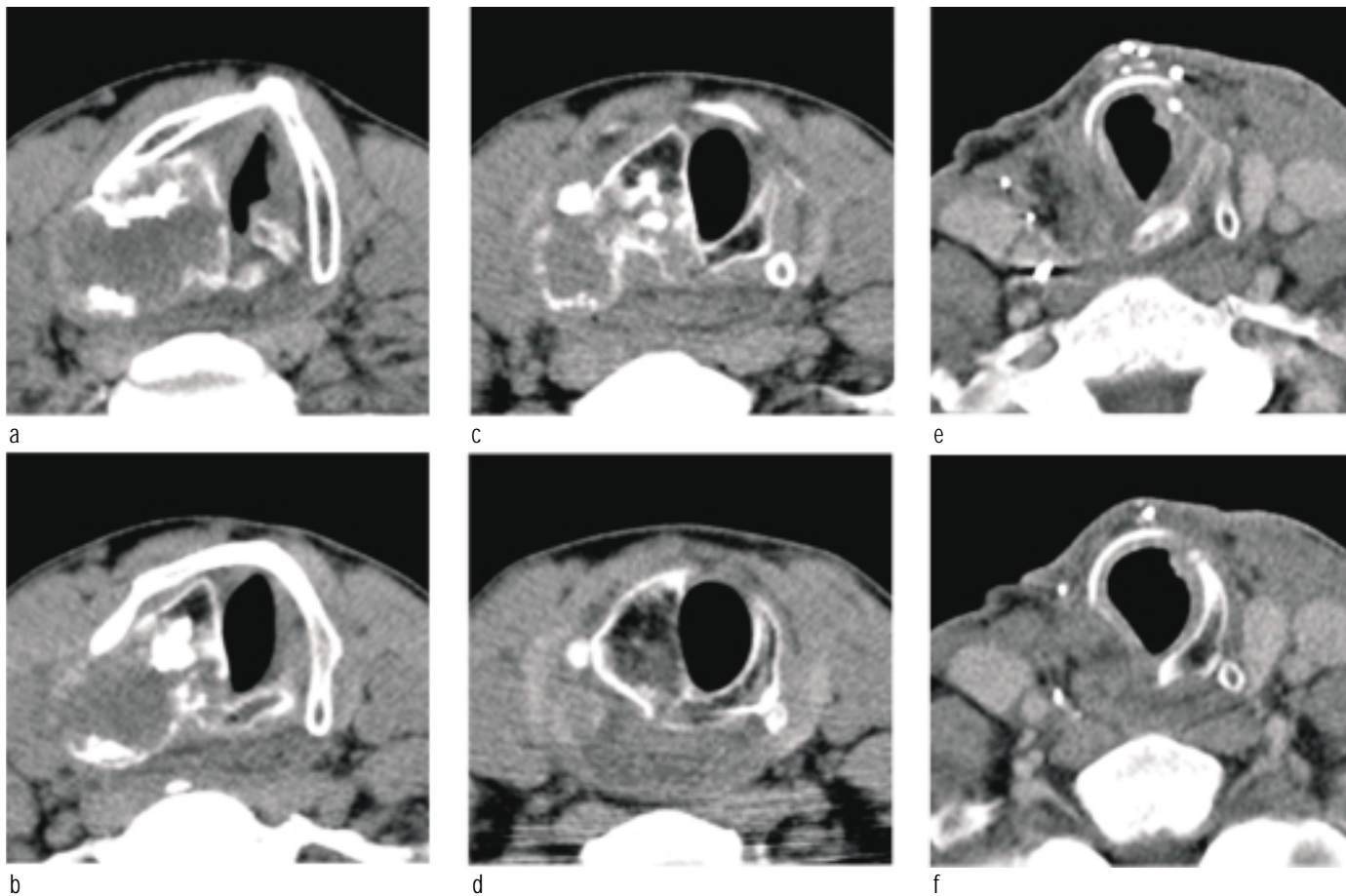
### C. Chondrosarcoma

Lateralized chondrosarcomas of the cricoid cartilage form an excellent indication for tracheal auto-transplantation. One chondrosarcoma was treated with the initial concept and three cases were treated with the modified concept. Of the three cases treated with the modified concept, 2 were considered large tumors while one, small tumor was treated differently.

#### C.1. Large tumor.

Two cases with a chondrosarcoma showed extensive tumor extension. The tumors were lateralized in both cases and they could be treated successfully with the modified autotransplantation concept (Fig. 5.47, 5.48).

The tumor was resected during the first operation and the definitive reconstruction occurred 4 months after the first operation.



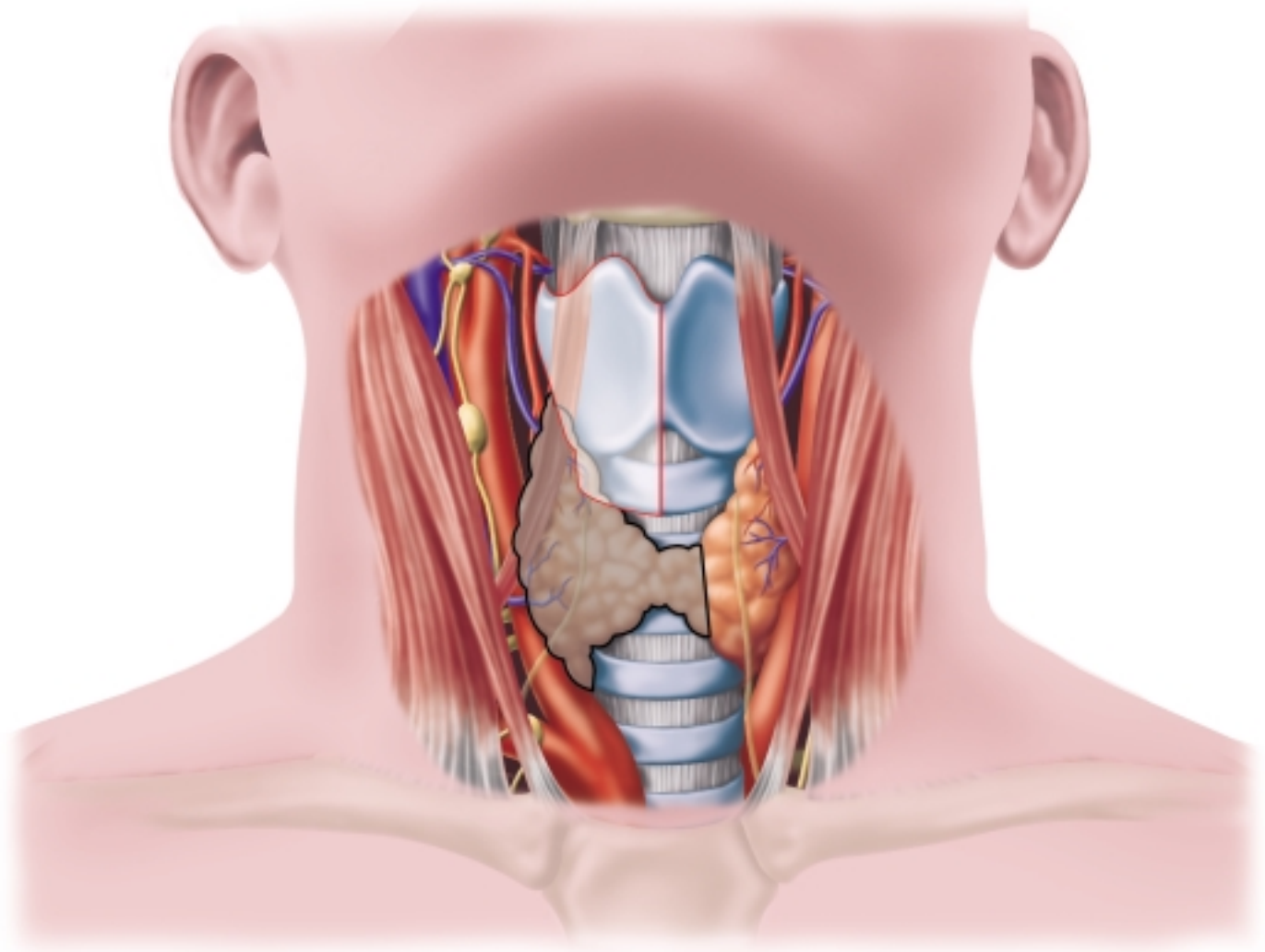
*Figure 5.47. Chondrosarcoma-large tumor.*  
*a. Preoperative glottic level.*  
*b., c. and d. Preoperative subglottic level.*  
*Lateralized chondrosarcoma of the subglottic area at the right side with involvement of the vocal fold.*

*e. and f. Postoperative situation after tracheal auto-transplantation. The tumor was resected by performing and extended hemilaryngectomy with tracheal autotransplantation.*

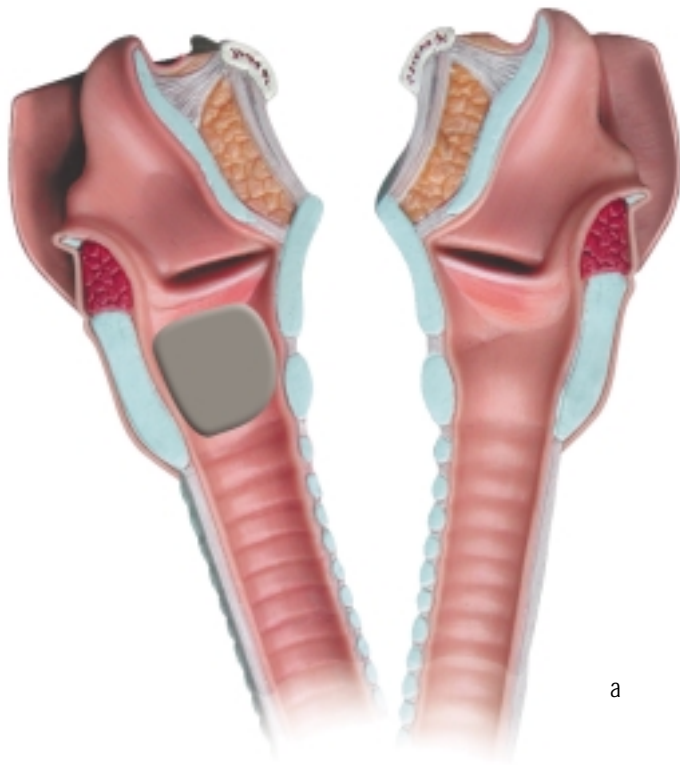
**C.2. Small tumor.**

One patient treated with the modified concept showed a small tumor. He (65-year-old male) was referred with the diagnosis of a chondrosarcoma of the left cricoid cartilage (Fig. 5.49). The patient was asymptomatic and the diagnosis was made on a CT scan that was taken because of cervical arthrosis. It was decided to treat the patient differently because the vocal fold and arytenoid was not

*Figure 5.48. Tracheal autotransplantation for large, unilateral chondrosarcoma. No neck dissection is performed. The ipsilateral thyroid gland will be removed for access (wrapping of trachea) and not for oncological reasons.*



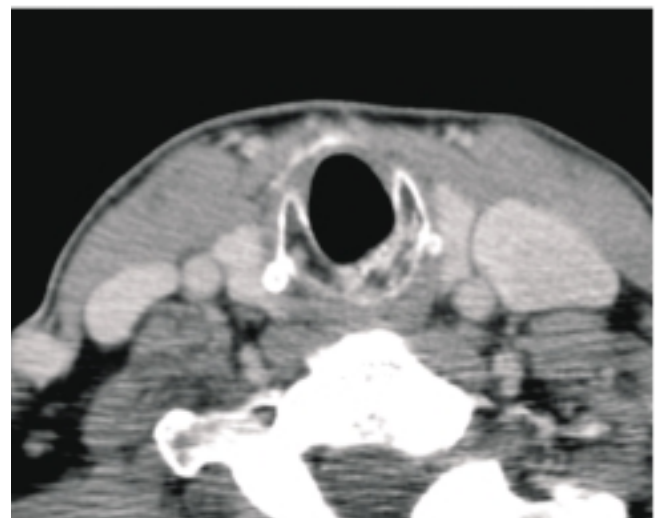
involved at the tumor side and because a laryngeal chondrosarcoma is usually low-grade with a very low tumor progression. In the first operation, the tumor was not resected. The cervical trachea was wrapped by fascia. Wrapping was done as in the modified concept and not circumferentially as in the initial concept (Fig. 5.50).



b

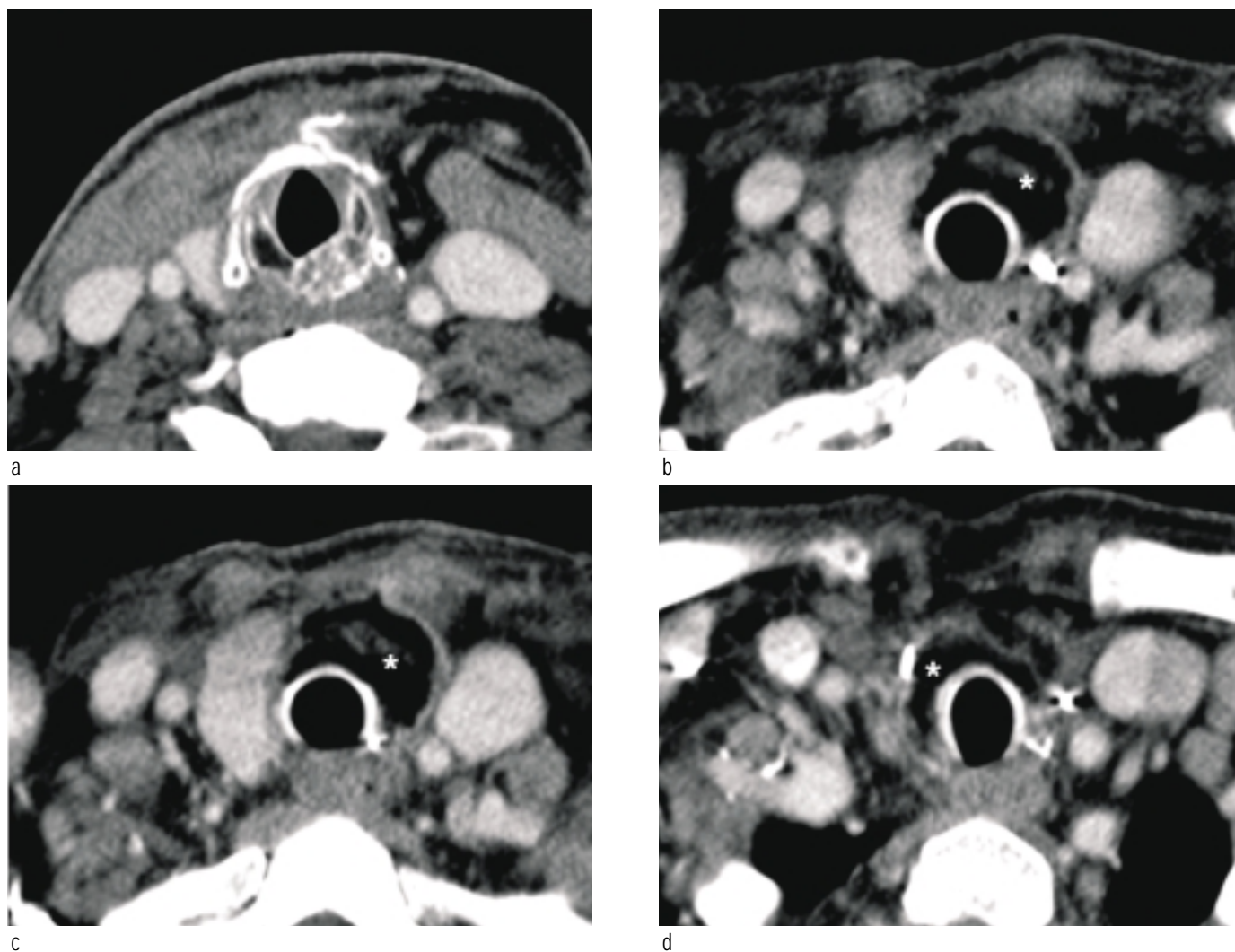


c



d

**Figure 5.49.**  
**Chondrosarcoma-small tumor.**  
*a. Amount of submucosal tumor infiltration.*  
*b., c., d. Axial CT scan showing extent of tumor.*  
*The left side of the cricoid cartilage is involved.*  
*The vocal fold and arytenoid are not involved.*



*Figure 5.50. Small chondrosarcoma- Axial CT scan after first operation.*

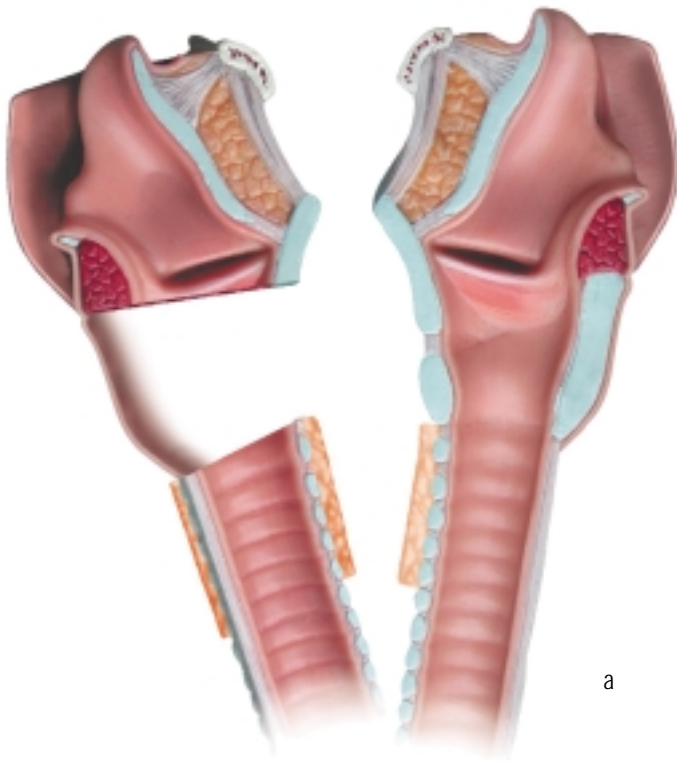
*a. Cricoid level. The tumor is not resected during the first operation.*

*b., c. and d. Tracheal level (from high to low). The upper 4 cm of trachea is wrapped with fascia following*

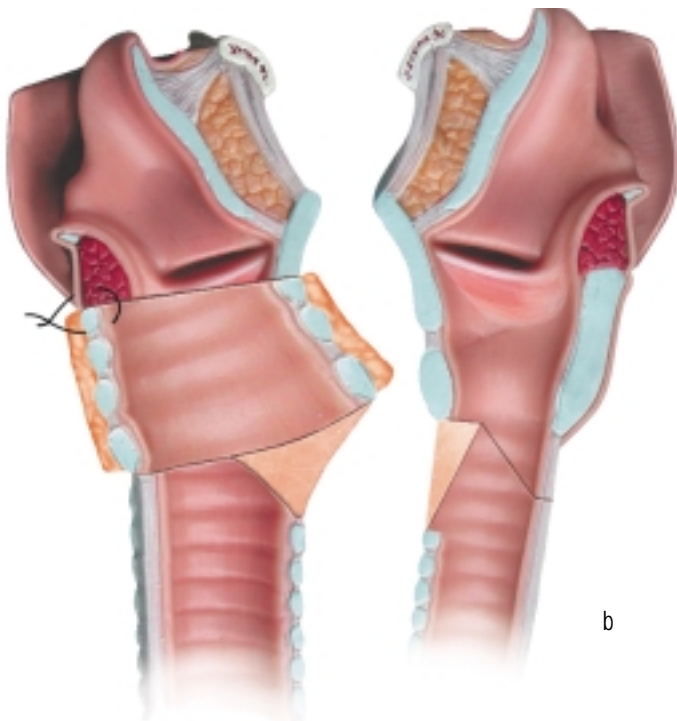
*the pattern of the modified concept: 3 cm of the circumference at the upper level and the full amount of cartilage ring at the lower level. Fascia is indicated by asterisks.*

Tumor resection and tracheal autotransplantation occurred 4 months after the first operation. Tumor removal was delayed to avoid the tracheostomy during the 4 month time interval. The posterior

forearm skin paddle necessary to create the posterior bulk was not warranted because the vocal fold and arytenoid was preserved at the tumor side (Fig. 5.51).



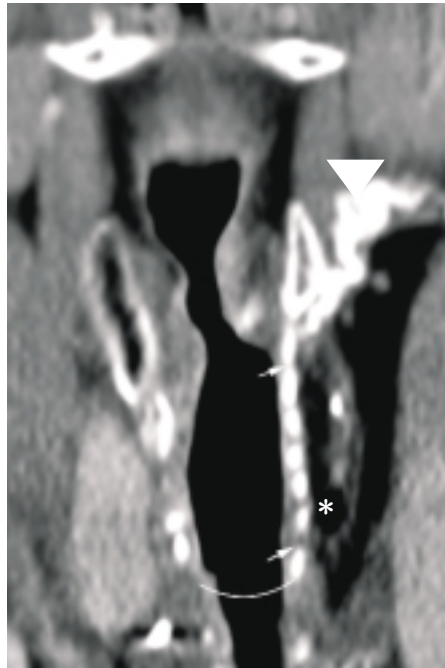
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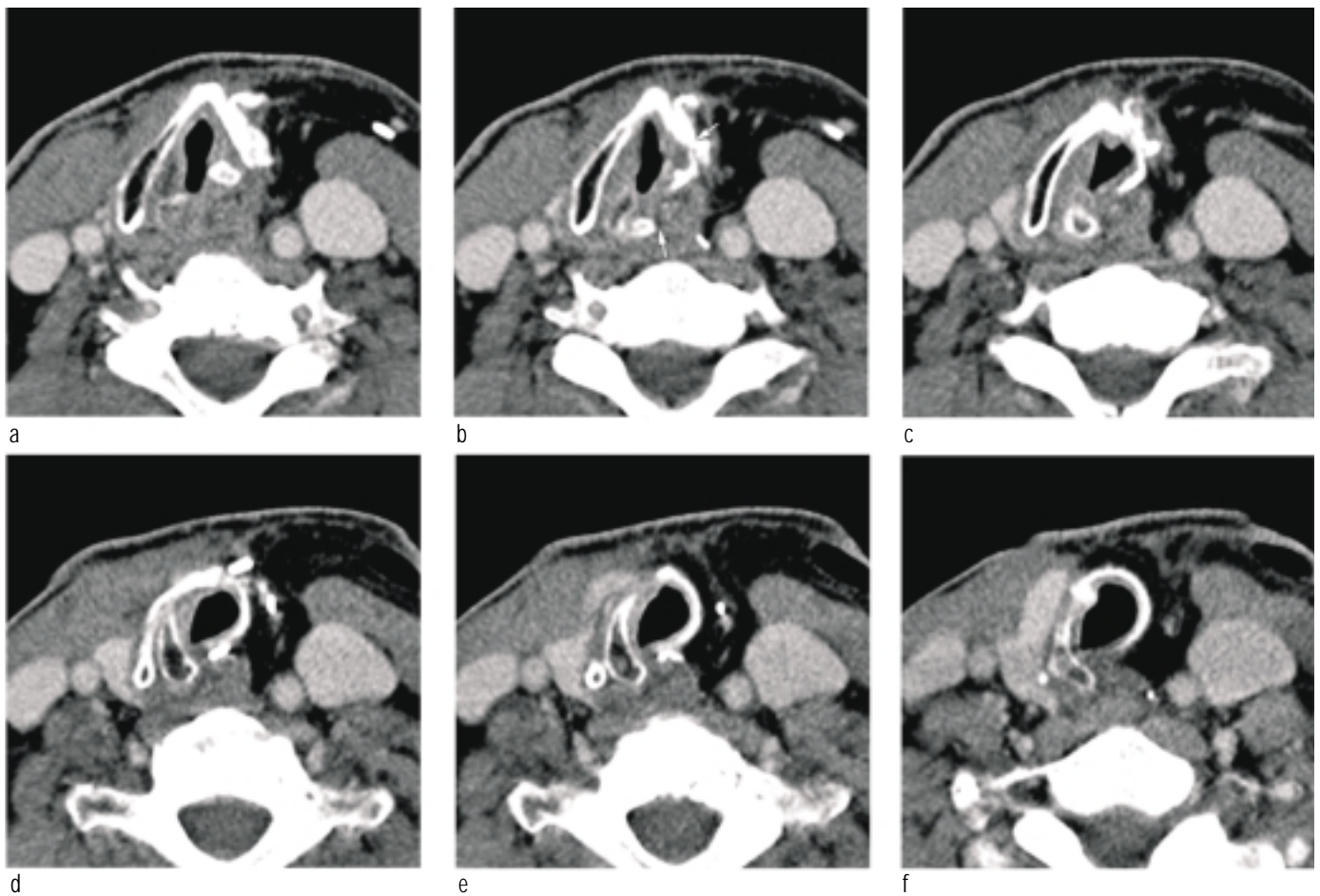
b

**Figure 5.51.**  
**Small chondrosarcoma- Second operation.**  
 a. Amount of tumor resection.  
 b. Situation after tracheal autotransplantation and closure of the tracheostomy.  
 The vocal fold and arytenoid at the tumor side were sutured to the superior margin of the tracheal autotransplant and they were placed in a midline position.

A tracheostomy was performed after the second operation and it was closed after 1 month under local anesthesia. Voice and swallowing function were excellent and comparable to a unilateral vocal fold paralysis in the midline position. Laryngeal morphology after reconstruction can be evaluated on the CT scan visible in Fig 5.52 and Fig. 5.53.



**Figure 5.52.**  
**Postoperative CT scan.** The coronal reformation shows the tracheal autotransplant repairing the subglottic larynx (between arrows). Fascia flap is indicated by asterisk. Anastomosis between mediastinal trachea and reconstructed larynx is indicated with white line. The preserved vocal fold and arytenoid are visible on top of the tracheal transplant. Arrowhead points to ePTFE membrane that remained in place.



**Figure 5.53. Postoperative CT scan-Axial sections.**  
*a. Supraglottic level. Left vocal fold is immobilized in medial position. The preserved arytenoid has become sclerotic.*  
*b. Glottic level. Tracheal transplant restores posterior site (between arrows).*

*c., d., e. and f. Subglottic level (from high to low). Hemicricoid defect is restored by revascularized trachea with full restoration of airway lumen.*

**Table 5.7.**

**Tracheal autotransplantation-Indications chondrosarcoma**

Large tumor lateralized

- Modified autotransplantation concept.
- Tumor resection during first operation.

Small tumor lateralized

- Modified autotransplantation concept (4 months time interval, no circumferential wrapping)
- Tumor resection during second operation with preservation of vocal fold and arytenoid.

The small chondrosarcoma could also be treated in a 1-stage procedure as described by Zur and Urken (ZUR et al. 2003). Only the subglottic area needs reconstruction and this can be done by doing a direct tracheal autotransplantation with the transplant pedicled on the superior thyroid artery and vein. The transfer of the trachea, with the adjacent thyroid gland, has been accomplished in a single-stage because of the ability to move the thyroid gland in a cephalad direction without the need to interrupt the inferior and superior blood

supplies. Tracheal autotransplantation on the thyroid artery and vein has the advantage of a 1-stage procedure but it is probably more risky than indirect revascularization. The tracheal transplant will be lost if the vascular supply through the superior thyroid vessels is interrupted. No second transplant can be taken, and the patient will become cannula dependent due to stenosis. Tracheal pre-fabrication is a safe procedure for preservation of the transplant viability. A second radial forearm flap can be taken in cases of flap failure during the first operation and the vascular pedicle needs no manipulation during the second intervention.

## 4. Conclusion

The key points of the optimal reconstructive technique are summarized in Table 4.8.

The radial forearm skin provides a midline reconstruction after the first operation with restoration of the sphincteric function.

The combination of the preserved radial forearm skin (at the posterior glottic and supraglottic level) with the tracheal patch provides for an optimal reconstruction after the second operation. (Fig. 5.54) with restoration of the sphincteric and respiratory function.

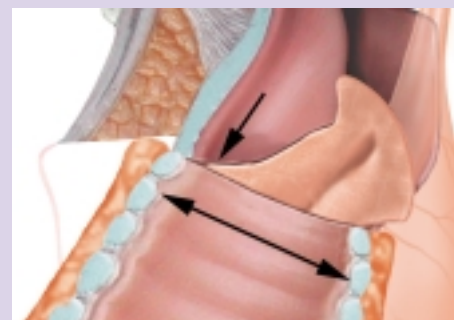
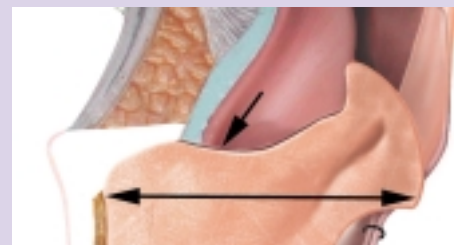
**Table 5.8.**  
Optimal reconstruction of extended hemilaryngectomy defects-KEY POINTS

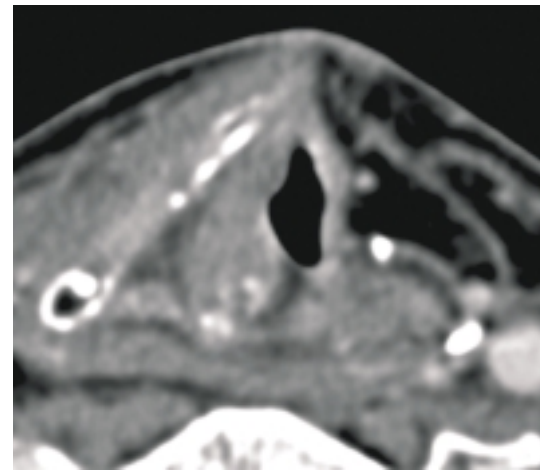
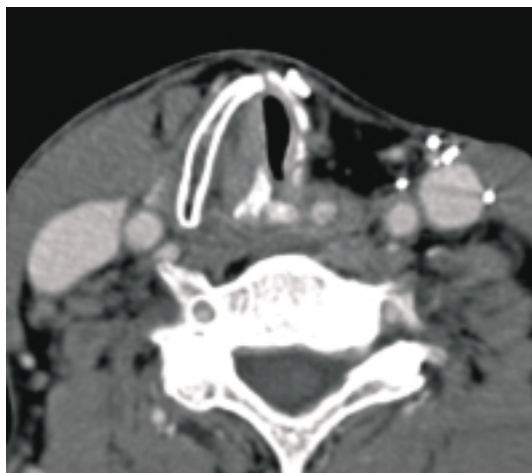
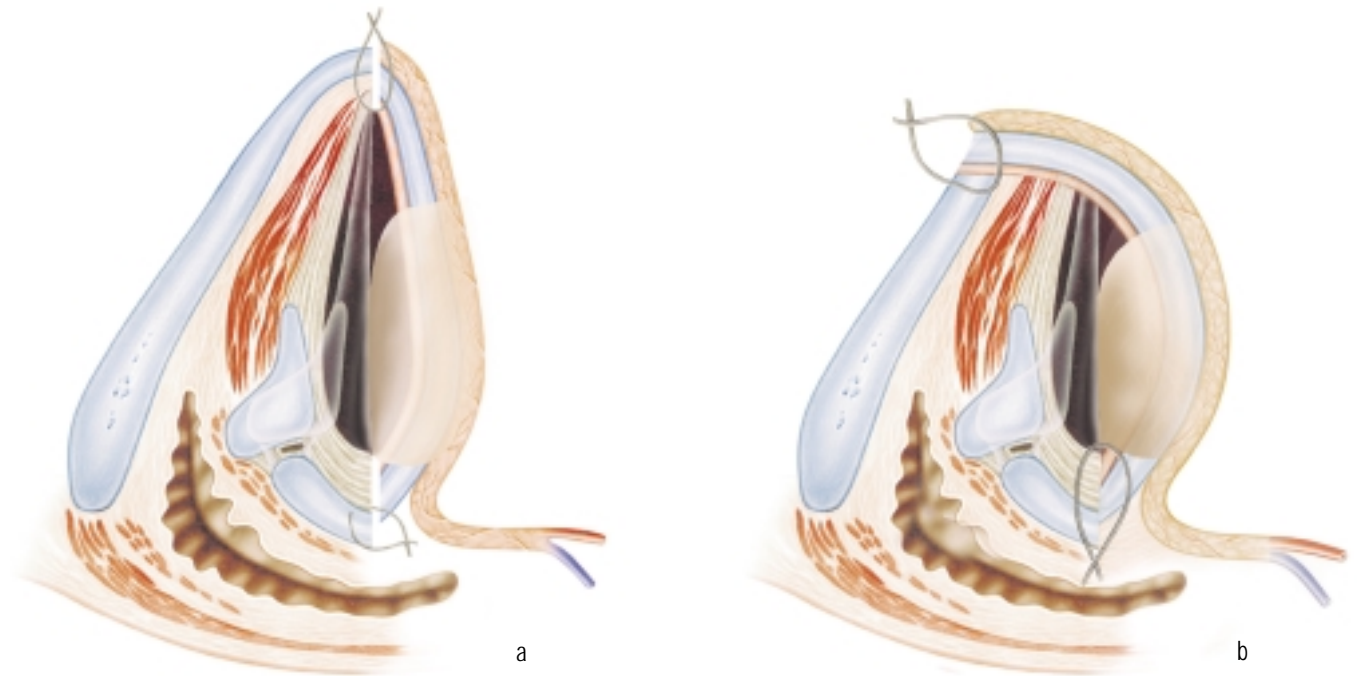
### First operation

- Width of forearm flap at glottic level: 3 cm (between 2.5 and 3.0 cm in females).
- Restoration of posterior bulk (mucosal incision over preserved arytenoid).
- Epiglottis is sutured to skin flap anteriorly at level of false vocal fold (arrow).

### Second operation

- Preservation of radial forearm skin posteriorly
- Width of tracheal patch at glottic level: 3 cm (between 2.5 and 3.0 cm in females).
- Full amount of tracheal patch is included inferiorly.
- Epiglottis is sutured to superior margin of tracheal patch anteriorly (no excessive forearm skin at supraglottic level anteriorly).





*Figure 5.54. Optimal reconstruction at glottic level in modified concept.*

*a. Anterior section in midline.*

*b. Anterior commissure included in resection.*

*The combination of forearm skin and tracheal patch*

*leads to an optimal morphology at the glottic level. The anterior larynx is the respiratory larynx; the posterior larynx is the sphincteric larynx.*

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Zur K, Urken M. Vascularized hemitracheal autograft for laryngotracheal reconstruction: a new surgical technique based on the thyroid gland as a vascular carrier. *Laryngoscope* 2003;113:1494-8.