Auris Nasus Larynx

Swallowing function improvement using costal cartilage for severe dysphagia after supracricoid hemilaryngopharyngectomy

--Manuscript Draft--

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Abstract:	Abstract Supracricoid hemilaryngopharyngectomy (SCHLP) is a laryngeal preservation surgery for hypopharyngeal carcinoma confined to the pyriform sinus or laryngeal carcinoma with arytenoid infiltration. Postoperative dysphagia is inevitable, but both voice and swallowing functions can be preserved. Here, we present a case of severe dysphagia secondary to unexpected postoperative tissue loss and scarring. A 67-year-old man underwent left SCHLP for hypopharyngeal cancer, and on the third postoperative day, he developed necrotizing fasciitis of the left neck. He was unable to swallow and was transferred to a rehabilitation hospital 90 days after the surgery. Six months after surgery, the patient had significant glottic insufficiency due to laryngeal deformity, constant massive salivary aspiration, and difficulty releasing the cuffed cannula. Severe dysphagia due to glottic insufficiency and laryngeal elevation insufficiency due to scar formation were considered, and laryngoplasty and laryngeal suspension surgery using costal cartilage were performed on the 221st postoperative day. After the reoperation, he was able to wear a speech valve and could speak and spit out, although his glottis was still closed. On the 70th day after the reoperation, he was able to consume three meals of an oral dysphagia diet and was discharged home.
Response to Reviewers:	

Yukio Katori MD, PhD
Editor in Chief
Auris Nasus Larynx

April 14, 2022

Dear Dr. Katori:

Thank you for the considering our manuscript for publication in *Auris Nasus Larynx*.
We are pleased to submit the revised version of our manuscript:
"Swallowing function improvement using costal cartilage for severe dysphagia after supracricoid hemilaryngopharyngectomy".
We appreciate the time spent by you and the reviewers and believe the revised manuscript has been improved.
Please consider the attached manuscript that has been revised according to the reviews.

We remain very enthusiastic about publishing our case report in *Auris Nasus Larynx* and look forward to your editorial decision.

Sincerely yours,

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Yukio Katori
Editor in Chief
Auris Nasus Larynx

April 12, 2022

Dear Editor:

Thank you for the considering our manuscript for publication in *Auris Nasus Larynx*. We appreciate the time spent by you and the reviewers and believe the revised manuscript has been improved. Below, we address the reviewers' comments.

We thank the reviewers for their careful review of the manuscript.

Reviewer #1:

Comment:

In this manuscript, the authors presented novel laryngeal preservation surgery in case of advanced hypopharyngeal carcinoma. Although this is the rare case that would have the potential to be published, there are some issues about the quality of this manuscript. Please see the comments as follows.

Reply:

We thank the reviewer for the careful review of the manuscript.

Major comments:

Comment 1:

Why did the patient develop necrotizing fasciitis of the left neck on three days after the first operation?

Reply 1:

As suggested, we described the cause of necrotizing fasciitis. "Although it was not determined immediately on onset, saliva outflow from the wound was confirmed at a later date, suggesting that necrotizing fasciitis was caused by wound infection due to the pharyngeal fistula".

Comment 2:

Five days after the first operation, the patient developed severe right hemiplegia caused by left cerebral infarction. Did his severe dysphagia due to not only laryngeal deformity but also ischemic stroke?

Reply 2:

As suggested, we described the evaluation items related to swallowing due to cerebral infarction in

the preoperative swallowing function evaluation. “As a functional evaluation related to swallowing after cerebral infarction, the durability of trunk functions, such as sitting position, was improved by rehabilitation, and the patient was able to maintain compensatory postures. No brain dysfunction, including cognitive decline, was observed. Furthermore, facial nerve palsy, hypoglossal nerve palsy and soft palate elevation failure were not observed. Movement of the tongue was maintained, and no conspicuous changes were observed during mastication, bolus formation, or induction of the swallowing reflex. In this case, we determined that dysphagia due to cerebral infarction was unclear“.

Comment 3:

Laryngeal suspension and costal cartilage placement in the second surgery were important points in this paper. What dose it mean to "… two costal cartilages approximately …, and fixed using the thyroid cartilage, cricoid cartilage, and hyoid bone."? Unfortunately, it is hard to imagine how they are fixed. Authors should show more details of surgical procedures.

Reply 3:

As suggested, we showed more details of surgical procedures. “since the left half of the hyoid bone and thyroid cartilage had been resected previously, laryngeal suspension was performed by suturing the remaining thyroid cartilage to the remaining hyoid bone and also the hyoid bone to the mandible. The distance between the hyoid bone and the mandible was 30 mm, and a 0-nylon suture was used. Laryngoplasty using costal cartilage was performed to form laryngeal closure from the glottis to the supraglottis and elevation at the supraglottis. The position of the supraglottis on the affected side was confirmed endoscopically by manual pressing from the outside, and costal cartilage was first placed in that location. At this time, the remaining tissue pushed inward using the cartilage was somewhat unstable. Therefore, the second costal cartilage was connected to the first cartilage at the glottic level on the caudal side. To stabilize the implanted cartilage, the caudal costal cartilage was placed between the deep tissues, using the remaining left anterior cervical muscle. The cephalic costal cartilage was sutured to the hyoid bone and thyroid cartilage, and the caudal costal cartilage was sutured to the thyroid and cricoid cartilage”.

Comment 4:

To improve swallowing function of the patient with cerebral infarction, cricopharyngeal myotomy often performed as a combined operation of laryngeal suspension. Why did not surgeons undergo cricopharyngeal myotomy？

Reply 4:

As suggested, we added the reason why we did not perform cricopharyngeal myotomy. “Since there

was no evidence of cricopharyngeal dysfunction on preoperative VF, we considered laryngeal suspension alone sufficient to treat this case".

Comment 5:

After the second surgery, the patient was able to speak by using speech valve. How is his voice? The authors should show some parameter indicating the quality of his voice.

Reply 5:

As suggested, we added about the quality of his voice after surgery. "The maximum phonation time (MPT) was approximately 4 s for false cord phonation".

Comment 6:

To preserve swallowing function after supracricoid hemilaryngopharyngectomy (SCHLP) or partial laryngectomy, it would be necessary to create an anatomical ridge (watershed) substituted for aryepiglottic fold or arytenoid (1). On the second surgery, laryngoplasty using costal cartilage was performed. What is the purpose of using two costal cartilages?

Reply 6:

As suggested, we added the purpose of using two costal cartilages in discussion. "in this case, to resolve the anatomical ridge defect in the supraglottis, the supraglottic level was confirmed with an endoscope, and a costal cartilage was implanted. As a single costal cartilage is unstable and in order to achieve a certain degree of closure at the glottic level, we decided to use two costal cartilages to close from the glottic to the supraglottic level".

Comment 7:

In the conclusion, the authors proposed that rigid laryngoplasty with costal cartilage improves swallowing function in patients with severe dysphagia after SCHLP by strengthening the glottis-upper glottis closure. Is it correct? Dose the laryngeal suspension also improve swallowing function?

Reply 7:

As suggested, we added discussion about conclusions. "In addition, preoperative evaluation of the swallowing function showed that it was essential to deal with laryngeal elevation failure due to scar formation in the neck; therefore, laryngeal elevation was also performed, which contributed to functional improvement".

Minor comments

Comment 1:

p4, line 7: her swallowing→his swallowing

Reply 1:

We apologize our careless mistakes and thank the reviewer for your careful check. We corrected the pointed part to “his”.

Comment 2:

p3, line 5: What dose it mean to "the laryngeal fissure"?

Reply 2:

We apologize our careless translation errors and thank the reviewer for your careful check. We corrected the pointed part from “involved the laryngeal fissure” to “infiltrated the arytenoid”.

Comment 3:

p3, line 5: What dose it mean to "a pear-shaped depression"?

Reply 3:

We apologize our careless translation errors and thank the reviewer for your careful check. We corrected the pointed part to “the pyriform sinus”.

Comment 4:

p3, line 12: What dose it mean to "a left capsular to coronary infarction"?

Reply 4:

We apologize our careless translation errors and thank the reviewer for your careful check. We corrected the pointed part to “a left cerebral infarction of the putamen to the corona radiata”.

Comment 5:

p3, line 17: Significant glottic closure was not observed in Figure-3a.

Reply 5:

We apologize our careless mistakes and thank the reviewer for your careful check. We corrected the pointed part from “glottic closure” to “glottic insufficiency”.

Comment 6:

p4, line 6: "severe dysphagia due to inadequate laryngeal elevation caused by inadequate glottis closure…" Was inadequate laryngeal elevation really caused by inadequate glottis closure?

Reply 6:

We revised the sentence to “severe dysphagia due to inadequate glottis closure and inadequate laryngeal elevation caused by neck scarring”

Comment 7:

p6, line 14: "…less sensitive carcinomas who wish to preserve larynx, as in this report." Is lymphoepithelial carcinoma less sensitive? Authors should show the reference about the radiation sensitivity of lymphoepithelial carcinoma.

Reply 7:

As suggested, we showed the reference [1]. This report states that patients undergoing primary surgery had a reduced chance of death from cancer than patients receiving primary radiotherapy (5-year disease-specific survival (DSS) 85.6 vs. 56.2%; $p = 0.04$).

Comment 8:

p7, line 6: What dose it mean to "after partial laryngectomy of hypopharynx"?

Reply 8:

We apologize our careless translation errors and thank the reviewer for your careful check. We corrected the pointed part to “extended vertical partial laryngectomy”.

Reviewer #2:

Comment:

Authors described that rigid laryngoplasty with costal cartilage improved swallowing function in patients with severe dysphagia after partial laryngectomy by strengthening the glottis-upper glottis closure. This case is informative, however there are several problems.

Reply:

We thank the reviewer for the careful review of the manuscript.

Comment 1:

Figure 2 (intraoperative findings and postoperative costal cartilage placement) is unclear as to location. Authors need to explain in detail.

Reply 1:

As suggested, we described Figure 2 in detail. Please refer to the reply 3 to the major comment 3 of Reviewer #1 too.

Comment 2:

Authors should describe first operation especially resection area.

Reply 2:

As suggested, we described first operation. “First, we performed a conservative neck dissection, followed by excision of the primary lesion according to the method reported by Laccourreye [4]. We incised the inferior constrictor muscle at the lateral edge of the thyroid cartilage to expose the cartilage. The cartilage membrane on the affected side was detached from the lateral edge to the midline, keeping it attached to the anterior cervical muscle. We incised the midline of the thyroid cartilage and entered the laryngeal lumen through the median of the anterior commissure. We partially resected the base of the epiglottis in the upper part and excised the thyroid cartilage plate and its contents, along the upper edge of the cricoid cartilage toward the arytenoid, in the lower part. With the pyriform sinus lesion under clear view, we excised the pyriform sinus mucosa with a safety margin of 10 mm.”.

Comment 3:

This patient developed severe right hemiplegia. It might affect the swallowing function in addition to postoperative factors. Authors need to analyze the swallowing function in detail. I think that it leads to an understanding of the need for each procedure.

Reply 3:

As suggested, we described the evaluation items related to swallowing due to cerebral infarction in the preoperative swallowing function evaluation. Please refer to the reply 2 to the major comment 2 of Reviewer #1.

Comment 4:

Figure legends Fig. 3 "(b)After reoperation" is duplicated.

Reply4:

We apologize our careless mistakes and thank the reviewer for your careful check. We removed the duplicate.

Editorial Office:

Comment 1:

Please change from "Summary" to "Abstract".

Reply 1:

We apologize our careless mistakes and thank the reviewer for your careful check. We corrected the pointed part to “Abstract”.

We remain very enthusiastic about publishing our case report in *Auris Nasus Larynx* and look forward to your editorial decision.

Sincerely yours,

1. Petruzzi G, Costantino A, De Virgilio A, Zocchi J, Campo F, Mercante G, et al. Lymphoepithelial carcinoma of larynx and hypopharynx: a systematic review and pooled analysis. Eur Arch Otorhinolaryngol 2022;279:1157-66.

Swallowing function improvement using costal cartilage for severe dysphagia after supracricoid hemilaryngopharyngectomy

Abstract

Supracricoid hemilaryngopharyngectomy (SCHLP) is a laryngeal preservation surgery for hypopharyngeal carcinoma confined to the pyriform sinus or laryngeal carcinoma with arytenoid infiltration. Postoperative dysphagia is inevitable, but both voice and swallowing functions can be preserved. Here, we present a case of severe dysphagia secondary to unexpected postoperative tissue loss and scarring. A 67-year-old man underwent left SCHLP for hypopharyngeal cancer, and on the third postoperative day, he developed necrotizing fasciitis of the left neck. He was unable to swallow and was transferred to a rehabilitation hospital 90 days after the surgery. Six months after surgery, the patient had significant glottic insufficiency due to laryngeal deformity, constant massive salivary aspiration, and difficulty releasing the cuffed cannula. Severe dysphagia due to glottic insufficiency and laryngeal elevation insufficiency due to scar formation were considered, and laryngoplasty and laryngeal suspension surgery using costal cartilage were performed on the 221st postoperative day. After the reoperation, he was able to wear a speech valve and could speak and spit out, although his glottis was still closed. On the 70th day after the reoperation, he was able to consume three meals of an oral dysphagia diet and was discharged home.

Keywords :

supracricoid hemilaryngopharyngectomy, dysphagia, laryngoplasty, costal cartilage, laryngeal suspension

1. Introduction

Supracricoid hemilaryngopharyngectomy (SCHLP) is a laryngeal preservation surgery for hypopharyngeal carcinoma confined to the pyriform sinus or laryngeal carcinoma with arytenoid infiltration [1, 2]. Postoperatively, the supraglottic tissues are used to maintain swallowing function and vocalization [3], with high percentage of laryngeal preservation [4, 5]. However, as with other partial laryngectomies, if severe postoperative dysphagia occurs, a long-term swallowing rehabilitation and surgery to improve swallowing function should be considered. It may be necessary to perform anti-aspiration surgery at the expense of voice function to prevent recurrent aspiration pneumonia. We recently encountered a case of postoperative tissue loss and scarring. For severe postoperative dysphagia, we devised a new technique for rigid reconstruction of the glottis and upper glottis using costal cartilage and laryngeal suspension surgery to improve swallowing function. Oral intake was possible after surgery, and the larynx was preserved.

2. Case report

A 67-year-old man with an unremarkable medical history was referred to a physician with hoarseness and was diagnosed with a hypopharyngeal tumor and left vocal fold

paralysis. Computed tomography revealed a tumor in the left pyriform sinus and enlarged lymph nodes ipsilaterally **(Fig. 1)**; however, no distant metastasis was found. Biopsy confirmed a diagnosis of lymphoepithelial carcinoma, and based on the image findings, the tumor was classified as T3N2M0. After chemotherapy, the patient was diagnosed with stable disease, and radical surgery was recommended considering radiation sensitivity. The patient had a strong desire to preserve his larynx. Since hypopharyngeal carcinoma infiltrated the arytenoid but was confined to the pyriform sinus, we performed SCHLP as indicated.

First, we performed a conservative neck dissection, followed by excision of the primary lesion according to the method reported by Laccourreye [4]. We incised the inferior constrictor muscle at the lateral edge of the thyroid cartilage to expose the cartilage. The cartilage membrane on the affected side was detached from the lateral edge to the midline, keeping it attached to the anterior cervical muscle. We incised the midline of the thyroid cartilage and entered the laryngeal lumen through the median of the anterior commissure. We partially resected the base of the epiglottis in the upper part and excised the thyroid cartilage plate and its contents, along the upper edge of the cricoid cartilage toward the arytenoid, in the lower part. With the pyriform sinus lesion under clear view, we excised the pyriform sinus mucosa with a safety margin of 10 mm. The glottis was reconstructed with a musculoperichondrial flap and one-stage suture. However, on the third postoperative day, the patient developed necrotizing fasciitis of the left neck,

requiring multiple debridement sessions. Although it was not determined immediately on onset, saliva outflow from the wound was confirmed at a later date, suggesting that necrotizing fasciitis was caused by wound infection due to the pharyngeal fistula. On the fifth postoperative day, the patient developed severe right hemiplegia, which was later confirmed to be due to a left cerebral infarction of the putamen to the corona radiata. Postoperatively, there was a high degree of saliva retention, and the larynx was difficult to observe. With a cuffed cannula in place, the patient was transferred to a rehabilitation center three months after surgery because he was unable to swallow. His physical function improved, and swallowing was evaluated six months after surgery. Laryngeal deformity caused a significant glottic insufficiency and loss of supraglottic elevation, resulting in constant salivary aspiration and difficulty in releasing the cuffed cannula. On a videofluoroscopic examination of swallowing (VF), subclinical aspiration during and after swallowing were marked, and 45-degree recline setting reduced the aspiration volume but showed pharyngeal residue. Although there was a marked difference in laryngeal elevation between the right and left sides, cervical rotation swallowing was attempted but was ineffective in removing residuals. As a functional evaluation related to swallowing after cerebral infarction, the durability of trunk functions, such as sitting position, was improved by rehabilitation, and the patient was able to maintain compensatory postures. No brain dysfunction, including cognitive decline, was observed. Furthermore, facial nerve palsy, hypoglossal nerve palsy and soft palate elevation failure

were not observed. Movement of the tongue was maintained, and no conspicuous changes were observed during mastication, bolus formation, or induction of the swallowing reflex. In this case, we determined that dysphagia due to cerebral infarction was unclear. The VF of the patient's preoperative swallowing condition can be viewed in Supplementary Video 1.

The patient was diagnosed with severe dysphagia due to inadequate glottis closure and inadequate laryngeal elevation caused by neck scarring and considered rehabilitation using a compensatory posture to improve his swallowing. He strongly desired to improve his quality of life (QOL) affected by saliva aspiration and dysphonia. Therefore, we performed a surgery to remove the scar, improve laryngeal elevation, and resolve glottic insufficiency to install a speech valve and enhance the sputum output. We believed that it was important to achieve a laryngeal closure at the upper glottis, and that rigid reconstruction was essential to form the glottis to upper glottis elevation. Therefore, we performed a surgery using costal cartilage on postoperative day 221. Since there was no evidence of cricopharyngeal dysfunction on preoperative VF, we considered laryngeal suspension alone sufficient to treat this case.

3. Operation

An inverted L-shaped skin incision was made at the level of the hyoid bone. First, the subcutaneous scar tissue was dissected and the anterior vertebral fascia was dissected from the surrounding tissue to allow passive movement of the larynx. Then, since the

left half of the hyoid bone and thyroid cartilage had been resected previously, laryngeal suspension was performed by suturing the remaining thyroid cartilage to the remaining hyoid bone and also the hyoid bone to the mandible. The distance between the hyoid bone and the mandible was 30 mm, and a 0-nylon suture was used. Laryngoplasty using costal cartilage was performed to form laryngeal closure from the glottis to the supraglottis and elevation at the supraglottis. The position of the supraglottis on the affected side was confirmed endoscopically by manual pressing from the outside, and costal cartilage was first placed in that location. At this time, the remaining tissue pushed inward using the cartilage was somewhat unstable. Therefore, the second costal cartilage was connected to the first cartilage at the glottic level on the caudal side. To stabilize the implanted cartilage, the caudal costal cartilage was placed between the deep tissues, using the remaining left anterior cervical muscle. The cephalic costal cartilage was sutured to the hyoid bone and thyroid cartilage, and the caudal costal cartilage was sutured to the thyroid and cricoid cartilage. The procedure was terminated after endoscopic confirmation that a certain degree of medial migration had been achieved. **(Fig. 2).**

3.1. Postoperative course

The patient was switched to a speech cannula on the seventh postoperative day, and VF was performed on the day the patient was able to speak. The maximum phonation time (MPT) was approximately 4 s for false cord phonation. Although mild aspiration was observed in the midline neck position, right cervical rotation reduced aspiration and improved the

amount of aspirated material that could be exhaled. The VF of the patient's postoperative swallowing condition can be viewed in Supplementary **Video 2**. We decided that it would be possible to begin swallowing rehabilitation with food. On the 70th day after reoperation, swallowing function improved to Food Intake LEVEL Scale (FILS) [6] level 7 (easy-to-swallow food is orally ingested in three meals). No alternative nutrition was provided, and the patient was discharged. Six months after the reoperation, he had improved to FILS level 8 (the patient eats three meals, excluding food that is particularly difficult to swallow) and had no pneumonia. Endoscopic findings showed that the upper glottis could be elevated to some extent, and that saliva retention and aspiration were reduced **(Fig. 3)**. No tumor recurrence was observed one year and four months after the initial surgery.

4. Discussion

In many cases of hypopharyngeal carcinoma, the cancer is already advanced at initial diagnosis [7], and total hypopharyngeal laryngectomy is often the standard surgical treatment. However, chemoradiation therapy (CRT) is the treatment of choice when laryngeal preservation is desired, because loss of voice function causes a significant decrease in QOL [8]. In cases of advanced hypopharyngeal cancer, salvage surgery is often required after CRT, where delayed wound healing is a problem [8]. SCHLP was proposed by Laccourreye [1, 4] and is established as a surgical technique. As CRT is increasingly used as a laryngeal preservation treatment, it is mainly indicated for

recurrent laryngeal cancer after radiotherapy. However, it is still considered a treatment option for patients with less sensitive carcinomas who wish to preserve their larynx, as in this report [9]. Although a temporary postoperative decrease in swallowing function is inevitable, it has been reported that 90% of patients can achieve swallowing function and laryngeal preservation postoperatively [4, 5]. Postoperatively, the patient was able to vocalize and swallow using a supraglottic structure [3]. In this case, postoperative infection caused an unexpected loss of supraglottic tissue. Scar formation restricted laryngeal elevation, making it difficult to process saliva and resulting in massive subclinical aspiration. In addition to closure of the supraglottic region, it is important to elevate the region at rest to achieve swallowing function and preserve the larynx, as aspiration occurs at the lower border between the aryepiglottic fold and the posterior commissure. Postoperative aspiration almost always occurs after resection of the supraglottic region, including the aryepiglottic fold and arytenoid cartilage [10]. Asada reported [11] that after extended vertical partial laryngectomy, suturing of the healthy arytenoid and epiglottis increased the level of the aryepiglottic fold, which was defective, allowing the patient to acquire oral intake. There is also a report of a soft reconstruction of the arytenoid to aryepiglottic fold using a free radial forearm tendocutaneous flap, which was able to maintain good function [12]. However, when closure is performed at the glottic to supraglottic level, rigid reconstruction is desirable for the purpose of forming a laryngeal framework in cases where the thyroid cartilage has been resected

more than half a side, but there have been no reported cases of two-stage rigid reconstruction of the larynx in the past.

As this case required manipulation of the scarred tissue after infection, we performed a laryngoplasty using costal cartilage, which is mainly used for the treatment of subglottic stenosis in children. Terra [13] reported that adults with glottic/subglottic stenosis who underwent costochondral reconstruction had a higher risk of wound infection than the pediatric population. Rich [14] mentioned that the difference between adult and pediatric costal cartilage engraftment may be due to the lack of scaffolding and necrosis of the skin valve caused by coexisting vasculopathic diseases in adults. At six months have after the reoperation, the costal cartilage was not become infected or dislodged, but we believe that careful observation is necessary in the future. In addition, in this case, to resolve the anatomical ridge defect in the supraglottis, the supraglottic level was confirmed with an endoscope, and a costal cartilage was implanted. As a single costal cartilage is unstable and in order to achieve a certain degree of closure at the glottic level, we decided to use two costal cartilages to close from the glottic to the supraglottic level. However, it was difficult to completely close the glottic levels using this technique. If the increase in aspiration caused by this procedure becomes a problem in the future, fat injection into the vocal folds [15] should be considered.

5. Conclusions

Rigid laryngoplasty with costal cartilage improves swallowing function in patients with

severe dysphagia after vertical partial laryngectomy, including SCHLP, by strengthening the glottis-upper glottis closure. In addition, preoperative evaluation of the swallowing function showed that it was essential to deal with laryngeal elevation failure due to scar formation in the neck; therefore, laryngeal elevation was also performed, which contributed to functional improvement. This case suggests that this method may be used to avoid aspiration prevention surgery.

Acknowledgements

We would like to thank Editage (www.editage.com) for English language editing.

Conflict of interest

The authors declare no conflict of interest.

References

1. Laccourreye H, Lacau St Guily J, Brasnu D, Fabre A, Menard M. Supracricoid hemilaryngopharyngectomy. Analysis of 240 cases. Ann Otol Rhinol Laryngol 1987;96:217-21.
2. Balatoni Z, Elö J. Indication and surgical technique for extended hemilaryngectomy. Eur Arch Otorhinolaryngol 1999;256:400-2.
3. Laccourreye O, Mérite-Drancy A, Brasnu D, Chabardes E, Cauchois R, Ménard M, et al. Supracricoid hemilaryngopharyngectomy in selected pyriform sinus carcinoma

staged as T2. The Laryngoscope 1993;103:1373-9.

4. Laccourreye O, Ishoo E, de Mones E, Garcia D, Kania R, Hans S. Supracricoid hemilaryngopharyngectomy in patients with invasive squamous cell carcinoma of the pyriform sinus. Part I: Technique, complications, and long-term functional outcome. Ann Otol Rhinol Laryngol 2005;114:25-34.

5. Papacharalampous GX, Kotsis GP, Vlastarakos PV, Georgolios A, Seggas I, Yiotakis IE, et al. Supracricoid hemilaryngopharyngectomy for selected pyriform sinus carcinoma patients--a retrospective chart review. World J Surg Oncol 2009;7:65.

6. Kunieda K, Ohno T, Fujishima I, Hojo K, Morita T. Reliability and Validity of a Tool to Measure the Severity of Dysphagia: The Food Intake LEVEL Scale. Journal of Pain and Symptom Management 2013;46:201-6.

7. Hall SF, Groome PA, Irish J, O'Sullivan B. The natural history of patients with squamous cell carcinoma of the hypopharynx. Laryngoscope 2008;118:1362-71.

8. Tsai YT, Chen WC, Chien CY, Hsu CM, Lee YC, Tsai MS, et al. Treatment patterns and survival outcomes of advanced hypopharyngeal squamous cell carcinoma. World J Surg Oncol 2020;18:82.

9. Petruzzi G, Costantino A, De Virgilio A, Zocchi J, Campo F, Mercante G, et al. Lymphoepithelial carcinoma of larynx and hypopharynx: a systematic review and pooled analysis. Eur Arch Otorhinolaryngol 2022;279:1157-66.

10. Holsinger FC, Laccourreye O, Weinstein GS, Diaz EM, Jr., McWhorter AJ. Technical

refinements in the supracricoid partial laryngectomy to optimize functional outcomes. J Am Coll Surg 2005;201:809-20.

11. Asada Y, Kurosawa K, Matsumoto K, Goto T, Katoh K, Imai T, et al. Laryngeal function-preserving operation for T4a laryngeal cancer with vocal cord paralysis - A case report. Auris Nasus Larynx 2018;45:194-9.
12. Mihara M, Iida T, Hara H, Hayashi Y, Yamamoto T, Mitsunaga N, et al. Reconstruction of the larynx and aryepiglottic fold using a free radial forearm tendocutaneous flap after partial laryngopharyngectomy: a case report. Microsurgery 2012;32:50-4.
13. Terra RM, Minamoto H, Carneiro F, Pego-Fernandes PM, Jatene FB. Laryngeal split and rib cartilage interpositional grafting: treatment option for glottic/subglottic stenosis in adults. J Thorac Cardiovasc Surg 2009;137:818-23.
14. Rich JT, Goldstein D, Haerle SK, Busato G-M, Gullane PJ, Gilbert RW. Vascularized composite autograft for adult laryngotracheal stenosis and reconstruction. Head & Neck 2016;38:253-9.
15. Mikaelian DO, Lowry LD, Sataloff RT. Lipoinjection for unilateral vocal cord paralysis. Laryngoscope 1991;101:465-8.

Fig. 1. Preoperative images. (a) Endoscopic image of the hypopharyngeal carcinoma (arrowhead) is seen on the left pyriform sinus. (b) Enhanced computed tomography. The

hypopharyngeal carcinoma (arrowhead) with enhancement extends into the parapharyngeal space and is draining the larynx.

Fig. 2. Intraoperative findings and postoperative costal cartilage placement (axial and coronal sections). (a) The harvested costal cartilage implanted at the supraglottic level (white arrowhead and dotted line) and glottic level (black arrowhead and dotted line). The tracheostomy (star) is shown on the caudal side of the figure. The caudal costal cartilage is inserted under the anterior cervical muscle (circle). (b1) Axial section, preoperative. The flap used for reconstruction is atrophied at the resection site (dotted line). (b2) Axial section, postoperative. The costal cartilage (dotted line and arrowhead) is used to move the tissue inward. (c1) Coronal section, preoperative. The gap between the glottis and the supraglottis is enlarged (arrow). (c2) Coronal section, postoperative. The costal cartilage (dotted line and arrowhead) is moved medially from the glottic and supraglottic levels.

Fig. 3. Postoperative endoscopic images. (a) After the first surgery. There is a defect in the upper glottal tissue (white arrowhead) and a high degree of aspiration of saliva from the upper glottis (black arrowhead). (b) After reoperation. The supraglottic level is raised (white arrowhead), and salivary residuals and intrusion are reduced (black arrowhead).

Swallowing function improvement using costal cartilage for severe dysphagia after supracricoid hemilaryngopharyngectomy

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Acknowledgements

We would like to thank Editage (www.editage.com) for English language editing.

Conflict of interest

The authors declare no conflict of interest.

Swallowing function improvement using costal cartilage for severe dysphagia after supracricoid hemilaryngopharyngectomy

Abstract

Supracricoid hemilaryngopharyngectomy (SCHLP) is a laryngeal preservation surgery for hypopharyngeal carcinoma confined to the pyriform sinus or laryngeal carcinoma with arytenoid infiltration. Postoperative dysphagia is inevitable, but both voice and swallowing functions can be preserved. Here, we present a case of severe dysphagia secondary to unexpected postoperative tissue loss and scarring. A 67-year-old man underwent left SCHLP for hypopharyngeal cancer, and on the third postoperative day, he developed necrotizing fasciitis of the left neck. He was unable to swallow and was transferred to a rehabilitation hospital 90 days after the surgery. Six months after surgery, the patient had significant glottic insufficiency due to laryngeal deformity, constant massive salivary aspiration, and difficulty releasing the cuffed cannula. Severe dysphagia due to glottic insufficiency and laryngeal elevation insufficiency due to scar formation were considered, and laryngoplasty and laryngeal suspension surgery using costal cartilage were performed on the 221st postoperative day. After the reoperation, he was able to wear a speech valve and could speak and spit out, although his glottis was still closed. On the 70th day after the reoperation, he was able to consume three meals of an oral dysphagia diet and was discharged home.

Keywords :

supracricoid hemilaryngopharyngectomy, dysphagia, laryngoplasty, costal cartilage, laryngeal suspension

1. Introduction

Supracricoid hemilaryngopharyngectomy (SCHLP) is a laryngeal preservation surgery for hypopharyngeal carcinoma confined to the pyriform sinus or laryngeal carcinoma with arytenoid infiltration [1, 2]. Postoperatively, the supraglottic tissues are used to maintain swallowing function and vocalization [3], with high percentage of laryngeal preservation [4, 5]. However, as with other partial laryngectomies, if severe postoperative dysphagia occurs, a long-term swallowing rehabilitation and surgery to improve swallowing function should be considered. It may be necessary to perform anti-aspiration surgery at the expense of voice function to prevent recurrent aspiration pneumonia. We recently encountered a case of postoperative tissue loss and scarring. For severe postoperative dysphagia, we devised a new technique for rigid reconstruction of the glottis and upper glottis using costal cartilage and laryngeal suspension surgery to improve swallowing function. Oral intake was possible after surgery, and the larynx was preserved.

2. Case report

A 67-year-old man with an unremarkable medical history was referred to a physician with hoarseness and was diagnosed with a hypopharyngeal tumor and left vocal fold

paralysis. Computed tomography revealed a tumor in the left pyriform sinus and enlarged lymph nodes ipsilaterally **(Fig. 1)**; however, no distant metastasis was found. Biopsy confirmed a diagnosis of lymphoepithelial carcinoma, and based on the image findings, the tumor was classified as T3N2M0. After chemotherapy, the patient was diagnosed with stable disease, and radical surgery was recommended considering radiation sensitivity. The patient had a strong desire to preserve his larynx. Since hypopharyngeal carcinoma infiltrated the arytenoid but was confined to the pyriform sinus, we performed SCHLP as indicated.

First, we performed a conservative neck dissection, followed by excision of the primary lesion according to the method reported by Laccourreye [4]. We incised the inferior constrictor muscle at the lateral edge of the thyroid cartilage to expose the cartilage. The cartilage membrane on the affected side was detached from the lateral edge to the midline, keeping it attached to the anterior cervical muscle. We incised the midline of the thyroid cartilage and entered the laryngeal lumen through the median of the anterior commissure. We partially resected the base of the epiglottis in the upper part and excised the thyroid cartilage plate and its contents, along the upper edge of the cricoid cartilage toward the arytenoid, in the lower part. With the pyriform sinus lesion under clear view, we excised the pyriform sinus mucosa with a safety margin of 10 mm. The glottis was reconstructed with a musculoperichondrial flap and one-stage suture. However, on the third postoperative day, the patient developed necrotizing fasciitis of the left neck,

requiring multiple debridement sessions. Although it was not determined immediately on onset, saliva outflow from the wound was confirmed at a later date, suggesting that necrotizing fasciitis was caused by wound infection due to the pharyngeal fistula. On the fifth postoperative day, the patient developed severe right hemiplegia, which was later confirmed to be due to a left cerebral infarction of the putamen to the corona radiata. Postoperatively, there was a high degree of saliva retention, and the larynx was difficult to observe. With a cuffed cannula in place, the patient was transferred to a rehabilitation center three months after surgery because he was unable to swallow. His physical function improved, and swallowing was evaluated six months after surgery. Laryngeal deformity caused a significant glottic insufficiency and loss of supraglottic elevation, resulting in constant salivary aspiration and difficulty in releasing the cuffed cannula. On a videofluoroscopic examination of swallowing (VF), subclinical aspiration during and after swallowing were marked, and 45-degree recline setting reduced the aspiration volume but showed pharyngeal residue. Although there was a marked difference in laryngeal elevation between the right and left sides, cervical rotation swallowing was attempted but was ineffective in removing residuals. As a functional evaluation related to swallowing after cerebral infarction, the durability of trunk functions, such as sitting position, was improved by rehabilitation, and the patient was able to maintain compensatory postures. No brain dysfunction, including cognitive decline, was observed. Furthermore, facial nerve palsy, hypoglossal nerve palsy and soft palate elevation failure

were not observed. Movement of the tongue was maintained, and no conspicuous changes were observed during mastication, bolus formation, or induction of the swallowing reflex. In this case, we determined that dysphagia due to cerebral infarction was unclear. The VF of the patient's preoperative swallowing condition can be viewed in Supplementary Video 1.

The patient was diagnosed with severe dysphagia due to inadequate glottis closure and inadequate laryngeal elevation caused by neck scarring and considered rehabilitation using a compensatory posture to improve his swallowing. He strongly desired to improve his quality of life (QOL) affected by saliva aspiration and dysphonia. Therefore, we performed a surgery to remove the scar, improve laryngeal elevation, and resolve glottic insufficiency to install a speech valve and enhance the sputum output. We believed that it was important to achieve a laryngeal closure at the upper glottis, and that rigid reconstruction was essential to form the glottis to upper glottis elevation. Therefore, we performed a surgery using costal cartilage on postoperative day 221. Since there was no evidence of cricopharyngeal dysfunction on preoperative VF, we considered laryngeal suspension alone sufficient to treat this case.

3. Operation

An inverted L-shaped skin incision was made at the level of the hyoid bone. First, the subcutaneous scar tissue was dissected and the anterior vertebral fascia was dissected from the surrounding tissue to allow passive movement of the larynx. Then, since the

left half of the hyoid bone and thyroid cartilage had been resected previously, laryngeal suspension was performed by suturing the remaining thyroid cartilage to the remaining hyoid bone and also the hyoid bone to the mandible. The distance between the hyoid bone and the mandible was 30 mm, and a 0-nylon suture was used. Laryngoplasty using costal cartilage was performed to form laryngeal closure from the glottis to the supraglottis and elevation at the supraglottis. The position of the supraglottis on the affected side was confirmed endoscopically by manual pressing from the outside, and costal cartilage was first placed in that location. At this time, the remaining tissue pushed inward using the cartilage was somewhat unstable. Therefore, the second costal cartilage was connected to the first cartilage at the glottic level on the caudal side. To stabilize the implanted cartilage, the caudal costal cartilage was placed between the deep tissues, using the remaining left anterior cervical muscle. The cephalic costal cartilage was sutured to the hyoid bone and thyroid cartilage, and the caudal costal cartilage was sutured to the thyroid and cricoid cartilage. The procedure was terminated after endoscopic confirmation that a certain degree of medial migration had been achieved. **(Fig. 2).**

3.1. Postoperative course

The patient was switched to a speech cannula on the seventh postoperative day, and VF was performed on the day the patient was able to speak. The maximum phonation time (MPT) was approximately 4 s for false cord phonation. Although mild aspiration was observed in the midline neck position, right cervical rotation reduced aspiration and improved the

amount of aspirated material that could be exhaled. The VF of the patient's postoperative swallowing condition can be viewed in Supplementary **Video 2**. We decided that it would be possible to begin swallowing rehabilitation with food. On the 70th day after reoperation, swallowing function improved to Food Intake LEVEL Scale (FILS) [6] level 7 (easy-to-swallow food is orally ingested in three meals). No alternative nutrition was provided, and the patient was discharged. Six months after the reoperation, he had improved to FILS level 8 (the patient eats three meals, excluding food that is particularly difficult to swallow) and had no pneumonia. Endoscopic findings showed that the upper glottis could be elevated to some extent, and that saliva retention and aspiration were reduced **(Fig. 3)**. No tumor recurrence was observed one year and four months after the initial surgery.

4. Discussion

In many cases of hypopharyngeal carcinoma, the cancer is already advanced at initial diagnosis [7], and total hypopharyngeal laryngectomy is often the standard surgical treatment. However, chemoradiation therapy (CRT) is the treatment of choice when laryngeal preservation is desired, because loss of voice function causes a significant decrease in QOL [8]. In cases of advanced hypopharyngeal cancer, salvage surgery is often required after CRT, where delayed wound healing is a problem [8]. SCHLP was proposed by Laccourreye [1, 4] and is established as a surgical technique. As CRT is increasingly used as a laryngeal preservation treatment, it is mainly indicated for

recurrent laryngeal cancer after radiotherapy. However, it is still considered a treatment option for patients with less sensitive carcinomas who wish to preserve their larynx, as in this report [9]. Although a temporary postoperative decrease in swallowing function is inevitable, it has been reported that 90% of patients can achieve swallowing function and laryngeal preservation postoperatively [4, 5]. Postoperatively, the patient was able to vocalize and swallow using a supraglottic structure [3]. In this case, postoperative infection caused an unexpected loss of supraglottic tissue. Scar formation restricted laryngeal elevation, making it difficult to process saliva and resulting in massive subclinical aspiration. In addition to closure of the supraglottic region, it is important to elevate the region at rest to achieve swallowing function and preserve the larynx, as aspiration occurs at the lower border between the aryepiglottic fold and the posterior commissure. Postoperative aspiration almost always occurs after resection of the supraglottic region, including the aryepiglottic fold and arytenoid cartilage [10]. Asada reported [11] that after extended vertical partial laryngectomy, suturing of the healthy arytenoid and epiglottis increased the level of the aryepiglottic fold, which was defective, allowing the patient to acquire oral intake. There is also a report of a soft reconstruction of the arytenoid to aryepiglottic fold using a free radial forearm tendocutaneous flap, which was able to maintain good function [12]. However, when closure is performed at the glottic to supraglottic level, rigid reconstruction is desirable for the purpose of forming a laryngeal framework in cases where the thyroid cartilage has been resected

more than half a side, but there have been no reported cases of two-stage rigid reconstruction of the larynx in the past.

As this case required manipulation of the scarred tissue after infection, we performed a laryngoplasty using costal cartilage, which is mainly used for the treatment of subglottic stenosis in children. Terra [13] reported that adults with glottic/subglottic stenosis who underwent costochondral reconstruction had a higher risk of wound infection than the pediatric population. Rich [14] mentioned that the difference between adult and pediatric costal cartilage engraftment may be due to the lack of scaffolding and necrosis of the skin valve caused by coexisting vasculopathic diseases in adults. At six months have after the reoperation, the costal cartilage was not become infected or dislodged, but we believe that careful observation is necessary in the future. In addition, in this case, to resolve the anatomical ridge defect in the supraglottis, the supraglottic level was confirmed with an endoscope, and a costal cartilage was implanted. As a single costal cartilage is unstable and in order to achieve a certain degree of closure at the glottic level, we decided to use two costal cartilages to close from the glottic to the supraglottic level. However, it was difficult to completely close the glottic levels using this technique. If the increase in aspiration caused by this procedure becomes a problem in the future, fat injection into the vocal folds [15] should be considered.

5. Conclusions

Rigid laryngoplasty with costal cartilage improves swallowing function in patients with

severe dysphagia after vertical partial laryngectomy, including SCHLP, by strengthening the glottis-upper glottis closure. In addition, preoperative evaluation of the swallowing function showed that it was essential to deal with laryngeal elevation failure due to scar formation in the neck; therefore, laryngeal elevation was also performed, which contributed to functional improvement. This case suggests that this method may be used to avoid aspiration prevention surgery.

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Conflict of interest

The authors declare no conflict of interest.

References

1. Laccourreye H, Lacau St Guily J, Brasnu D, Fabre A, Menard M. Supracricoid hemilaryngopharyngectomy. Analysis of 240 cases. Ann Otol Rhinol Laryngol 1987;96:217-21.
2. Balatoni Z, Elö J. Indication and surgical technique for extended hemilaryngectomy. Eur Arch Otorhinolaryngol 1999;256:400-2.
3. Laccourreye O, Mérite-Drancy A, Brasnu D, Chabardes E, Cauchois R, Ménard M, et al. Supracricoid hemilaryngopharyngectomy in selected pyriform sinus carcinoma

staged as T2. The Laryngoscope 1993;103:1373-9.

4. Laccourreye O, Ishoo E, de Mones E, Garcia D, Kania R, Hans S. Supracricoid hemilaryngopharyngectomy in patients with invasive squamous cell carcinoma of the pyriform sinus. Part I: Technique, complications, and long-term functional outcome. Ann Otol Rhinol Laryngol 2005;114:25-34.

5. Papacharalampous GX, Kotsis GP, Vlastarakos PV, Georgolios A, Seggas I, Yiotakis IE, et al. Supracricoid hemilaryngopharyngectomy for selected pyriform sinus carcinoma patients--a retrospective chart review. World J Surg Oncol 2009;7:65.

6. Kunieda K, Ohno T, Fujishima I, Hojo K, Morita T. Reliability and Validity of a Tool to Measure the Severity of Dysphagia: The Food Intake LEVEL Scale. Journal of Pain and Symptom Management 2013;46:201-6.

7. Hall SF, Groome PA, Irish J, O'Sullivan B. The natural history of patients with squamous cell carcinoma of the hypopharynx. Laryngoscope 2008;118:1362-71.

8. Tsai YT, Chen WC, Chien CY, Hsu CM, Lee YC, Tsai MS, et al. Treatment patterns and survival outcomes of advanced hypopharyngeal squamous cell carcinoma. World J Surg Oncol 2020;18:82.

9. Petruzzi G, Costantino A, De Virgilio A, Zocchi J, Campo F, Mercante G, et al. Lymphoepithelial carcinoma of larynx and hypopharynx: a systematic review and pooled analysis. Eur Arch Otorhinolaryngol 2022;279:1157-66.

10. Holsinger FC, Laccourreye O, Weinstein GS, Diaz EM, Jr., McWhorter AJ. Technical

refinements in the supracricoid partial laryngectomy to optimize functional outcomes. J Am Coll Surg 2005;201:809-20.

11. Asada Y, Kurosawa K, Matsumoto K, Goto T, Katoh K, Imai T, et al. Laryngeal function-preserving operation for T4a laryngeal cancer with vocal cord paralysis - A case report. Auris Nasus Larynx 2018;45:194-9.
12. Mihara M, Iida T, Hara H, Hayashi Y, Yamamoto T, Mitsunaga N, et al. Reconstruction of the larynx and aryepiglottic fold using a free radial forearm tendocutaneous flap after partial laryngopharyngectomy: a case report. Microsurgery 2012;32:50-4.
13. Terra RM, Minamoto H, Carneiro F, Pego-Fernandes PM, Jatene FB. Laryngeal split and rib cartilage interpositional grafting: treatment option for glottic/subglottic stenosis in adults. J Thorac Cardiovasc Surg 2009;137:818-23.
14. Rich JT, Goldstein D, Haerle SK, Busato G-M, Gullane PJ, Gilbert RW. Vascularized composite autograft for adult laryngotracheal stenosis and reconstruction. Head & Neck 2016;38:253-9.
15. Mikaelian DO, Lowry LD, Sataloff RT. Lipoinjection for unilateral vocal cord paralysis. Laryngoscope 1991;101:465-8.

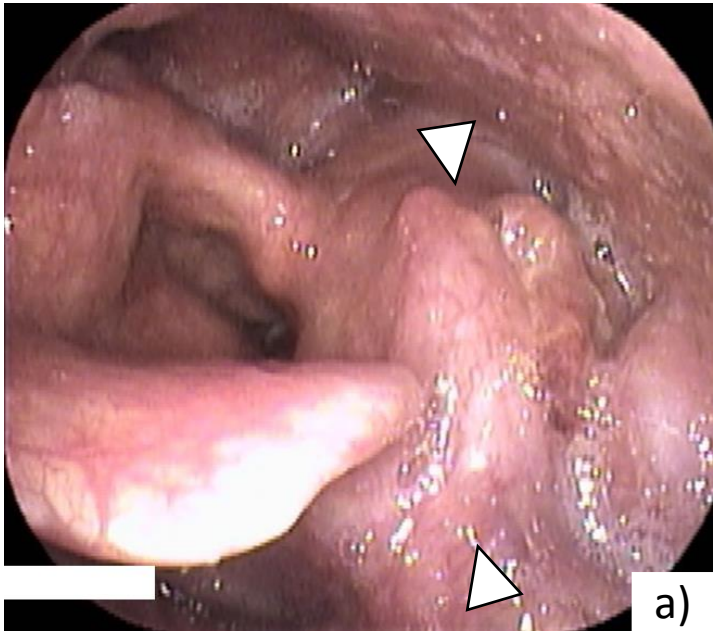
Fig. 1. Preoperative images. (a) Endoscopic image of the hypopharyngeal carcinoma (arrowhead) is seen on the left pyriform sinus. (b) Enhanced computed tomography. The

hypopharyngeal carcinoma (arrowhead) with enhancement extends into the parapharyngeal space and is draining the larynx.

Fig. 2. Intraoperative findings and postoperative costal cartilage placement (axial and coronal sections). (a) The harvested costal cartilage implanted at the supraglottic level (white arrowhead and dotted line) and glottic level (black arrowhead and dotted line). The tracheostomy (star) is shown on the caudal side of the figure. The caudal costal cartilage is inserted under the anterior cervical muscle (circle). (b1) Axial section, preoperative. The flap used for reconstruction is atrophied at the resection site (dotted line). (b2) Axial section, postoperative. The costal cartilage (dotted line and arrowhead) is used to move the tissue inward. (c1) Coronal section, preoperative. The gap between the glottis and the supraglottis is enlarged (arrow). (c2) Coronal section, postoperative. The costal cartilage (dotted line and arrowhead) is moved medially from the glottic and supraglottic levels.

Fig. 3. Postoperative endoscopic images. (a) After the first surgery. There is a defect in the upper glottal tissue (white arrowhead) and a high degree of aspiration of saliva from the upper glottis (black arrowhead). (b) After reoperation. The supraglottic level is raised (white arrowhead), and salivary residuals and intrusion are reduced (black arrowhead).

Figure.1



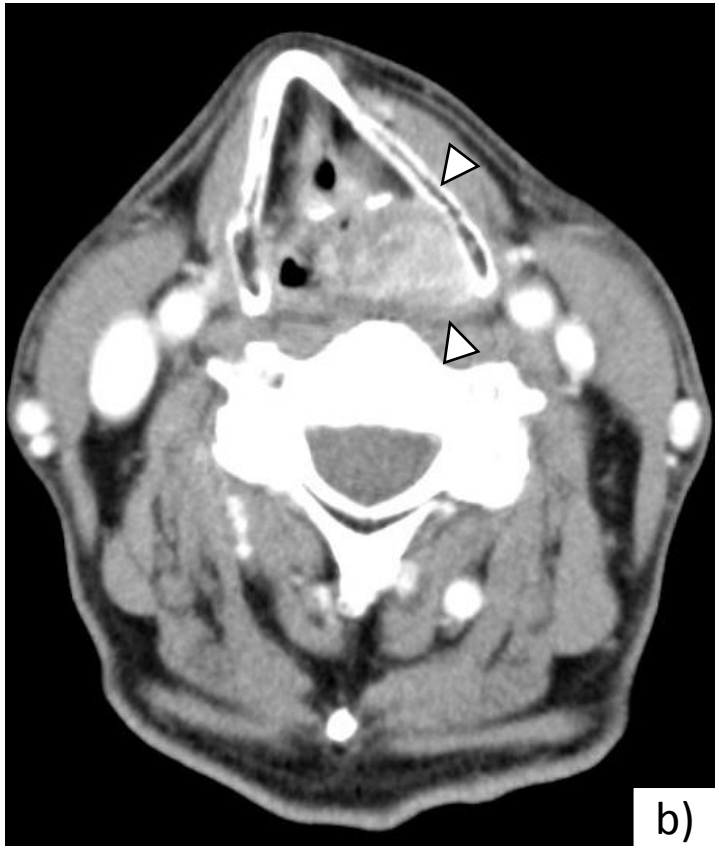
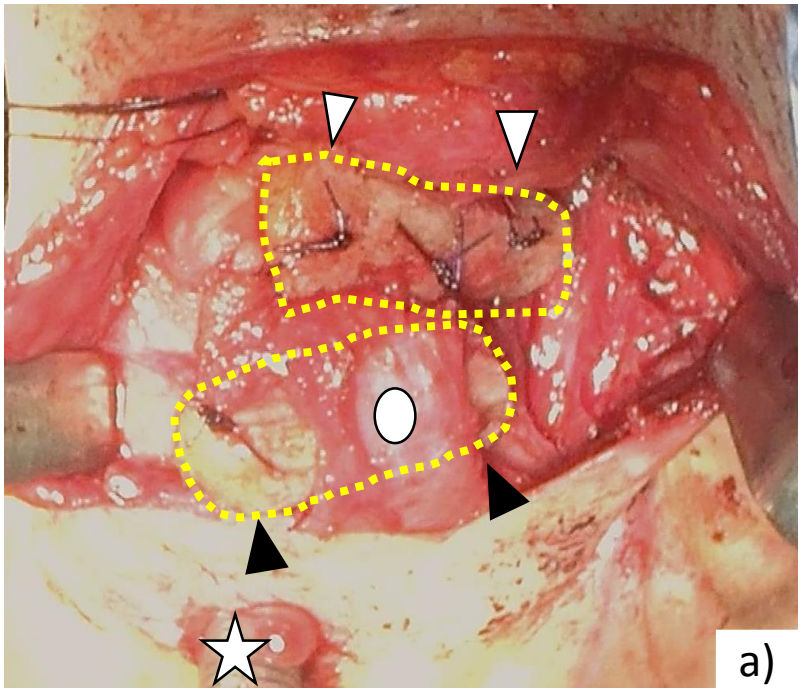
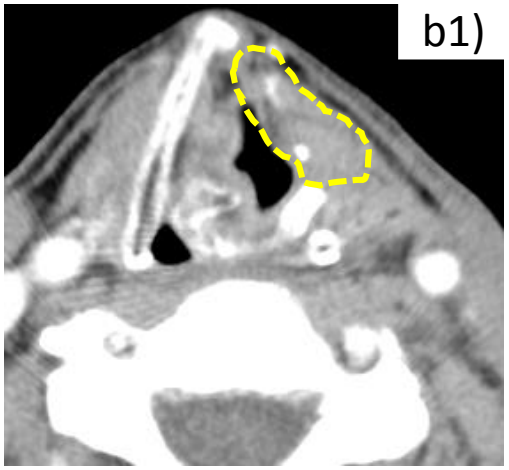
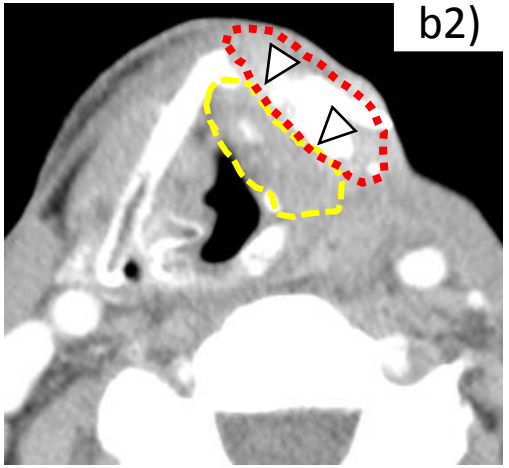
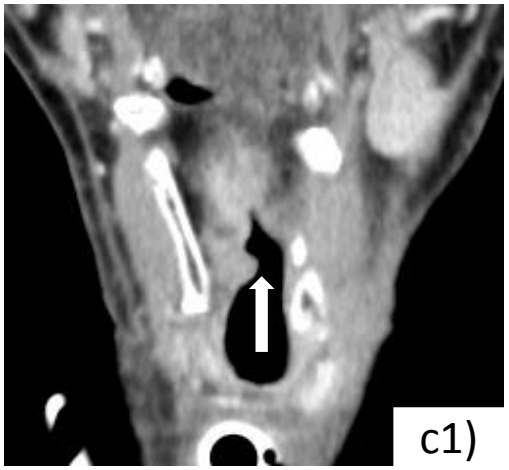


Figure.2









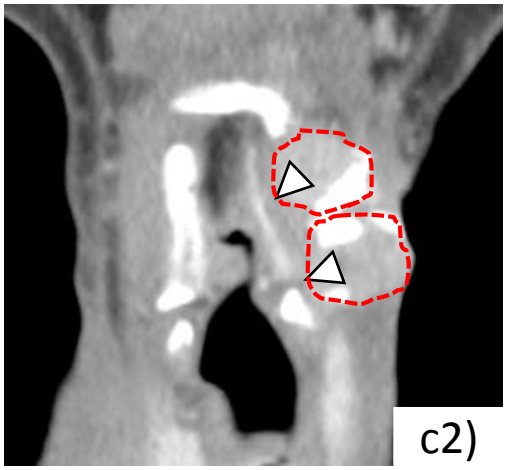


Figure.3