

Carotid Endarterectomy Requiring Removal of the Superior Horn of Thyroid Cartilage: Case Report and Literature Review

Takayuki ISHIKAWA,¹ Kazuho MORIBE,² Keishi ITO,¹
and Ryusuke KABEYA¹

¹*Department of Neurosurgery, Ichinomiya Municipal Hospital, Ichinomiya, Aichi, Japan*

²*Department of Otorhinolaryngology, Ichinomiya Municipal Hospital, Ichinomiya, Aichi, Japan*

Abstract

Carotid endarterectomy (CEA) is an established surgical procedure for carotid stenosis. We present the case of a 74-year-old man who underwent CEA for symptomatic internal carotid artery (ICA) stenosis. During the operation, we found that the hyoid bone (HB) and the superior horn of the thyroid cartilage covered the carotid sheath, preventing adequate visualization. Since this was anticipated based on preoperative examinations, the superior horn of thyroid cartilage was removed with the help of an otorhinolaryngologist. The HB was preserved because it could be retracted, and thereafter we performed CEA. Although CEA is a common procedure, the HB and thyroid cartilage are rarely involved in the operation. We present a case report including literature review of acute cerebrovascular syndrome (ACVS) due to HB and thyroid cartilage obstruction.

Keywords: carotid endarterectomy, superior horn of thyroid cartilage, superior thyroid cornu syndrome, hyoid–larynx complex

Introduction

The carotid artery typically runs lateral to the hyoid bone (HB) and thyroid cartilage, and in carotid endarterectomy (CEA), these structures generally do not obstruct the procedure. A few reports have shown resection of the HB during CEA¹ but there are no reports about resection of the superior horn of thyroid cartilage (SHTC) during CEA. In this study, we report a case of CEA requiring resection of the SHTC. The patient provided consent for this case report, and it was exempted from institutional review board approval at our institution.

Case Presentation

A 74-year-old male who had a previous history of right cerebral cortical infarction was under treatment

by neurologists. MRA performed about 3 months prior showed the right carotid artery had severe stenosis, for which we were consulted about surgical treatment. Three-dimensional CTA (3D-CTA) (Fig. 1) detected highly calcified bilateral carotid arteries, and the right side was especially severe. We found that it would be difficult to perform CEA, because the right internal carotid artery (ICA) was positioned abnormally medial to the external carotid artery (ECA) around a bifurcation. This anomaly is called as lateral ECA, lateral position of ECA, or twisted carotid bifurcation.² Furthermore, the right carotid artery extended medial to the right greater horn of HB and the SHTC. Carotid artery stenting (CAS) was also considered, but the calcification was so severe in the entire circumference that CAS would be extremely difficult. We consulted an otorhinolaryngologist and decided to perform CEA with resection of the HB and SHTC.

After skin and platysma incision and retraction of the sternocleidomastoid muscle, the greater horn of HB and SHTC was detected easily (Fig. 2). 3D-CTA revealed that these two structures covered the carotid

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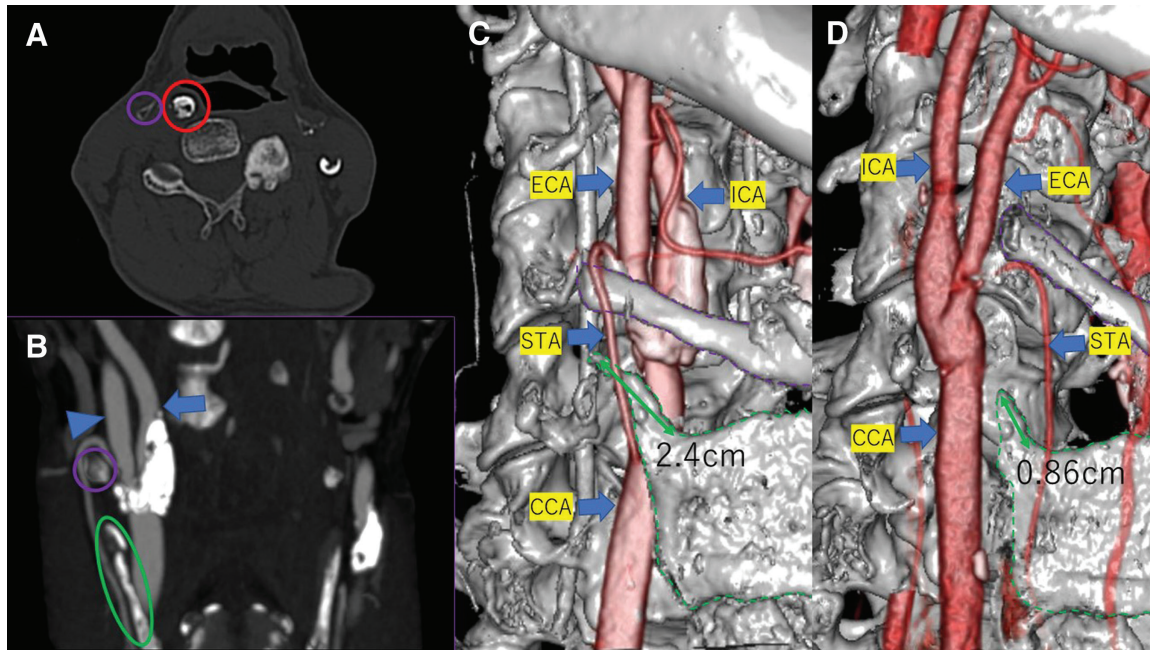


Fig. 1 3D-CT angiography. (A) Preoperative non-enhanced CT: Right ICA was highly calcified (red circle). Hyoid bone (HB) (purple circle) was positioned lateral to ICA. (B) Preoperative 3D-CTA MIP image: ICA ran medial to ECA. HB (purple circle) and superior horn of thyroid cartilage (SHTC) (green circle) positioned lateral to carotid arteries. (C) Preoperative 3D-CTA reconstruction image: ICA (arrow) ran medial to ECA (arrowhead). HB and SHTC covered carotid artery. The length of SHTC was 2.4 cm. (D) Postoperative 3D-CTA reconstruction image: ICA and HB both return to their natural position. SHTC was partially removed and its length was 0.86 cm. ECA: external carotid artery, ICA: internal carotid artery.

artery, but there was no compression or adherence between these bony structures and the carotid artery that would compromise the operation. After dissecting membrane tissue on the inferior side of the greater horn of HB, we identified the lateral thyrohyoid ligament and cut it. Then, we were able to retract the HB medially with light force, but the SHTC could not be retracted. We continued dissection of connective tissue around the SHTC, being careful not to injure the superior laryngeal nerve and artery. These are often positioned between the HB and thyroid cartilage. After exposing where the SHTC covered the carotid artery and obstructed the surgical corridor, we removed about 1.5 cm of the SHTC. We did not cut in the body of thyroid cartilage. Following these procedures, we performed CEA. Because we did not feel difficulty in exposing distal ICA and STA ran laterally, we finished CEA without normalizing the positions of ICA and ECA. After the operation, the patient experienced slight dysphagia and pharyngeal discomfort, but he recovered without additional treatment after 1 week. Postoperative 3D-CTA showed ICA running naturally after surgery (Fig. 1D). He was discharged 8 days after the surgery.

Discussion

CEA is an established treatment for carotid stenosis. Typically, the HB and SHTC do not obstruct the corridor, because these structures are positioned medial to the carotid sheath. In this case, the greater horn of the HB and SHTC was positioned in front of the carotid sheath. There have been no reports about CEA requiring removal of SHTC obstructing surgical corridor. In a similar situation, O'Connor et al. reported anterior cervical discectomy and fusion requiring SHTC resection.³⁾ The hyoid–larynx complex has many anatomical variations, and the frequency of permutation has been reported to be relatively high, 4%–30%.⁴⁾ The greater horn of HB and SHTC develops from the third and fourth branchial arches, respectively. Morphological abnormalities often occur in both. These anomalies do not always obstruct the surgical corridor, but surgeons operating in the cervical region should be aware of this possibility. Furthermore, care should be taken when creating a 3D-CTA reconstructed image, because cartilage with low intensity visualized using CT can be excluded automatically by the software.

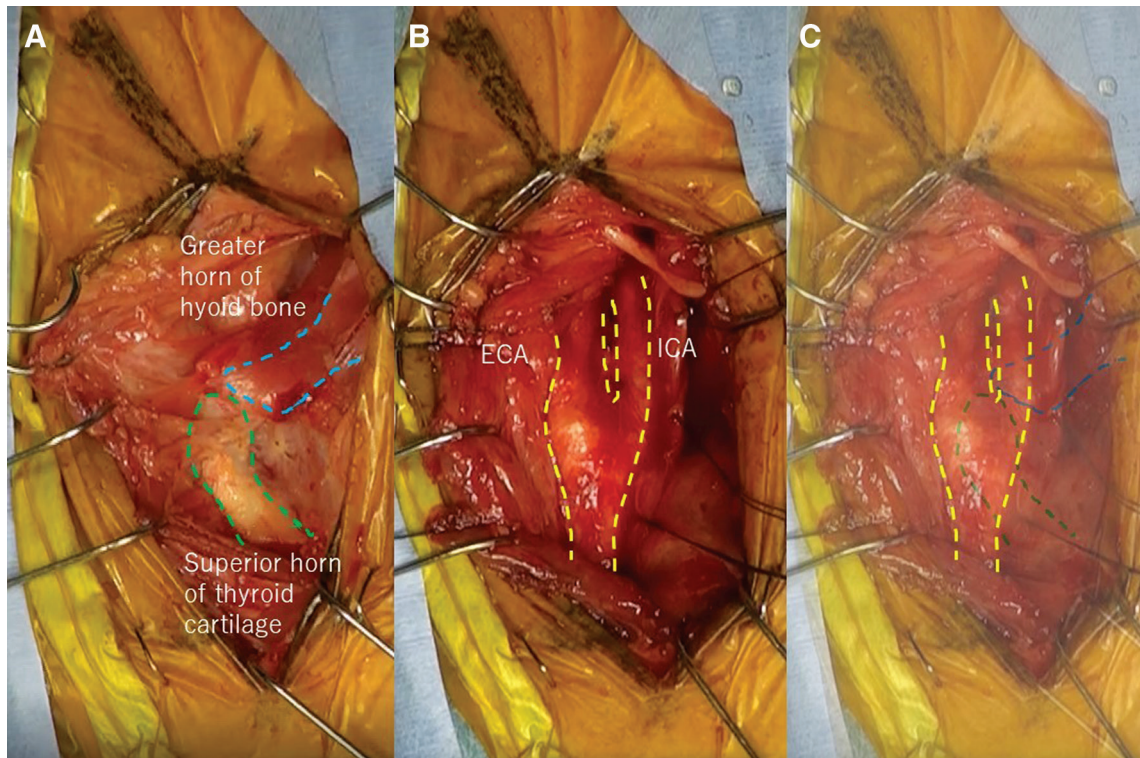


Fig. 2 Intraoperative view. (A) The view after retracting sternocleidomastoid muscle posteriorly. The blue dotted line shows the line of greater horn of hyoid bone (HB), and the green dotted line shows the superior horn of thyroid cartilage (SHTC). (B) The view after retracting HB and removal SHTC and dissecting connective tissue around carotid sheath. ECA: external carotid artery, ICA: internal carotid artery. (C) Superimposition of the views in (A) and (B). While the images in (A) and (B) were photographed, the camera was not moved, and zoom or focus operations were not performed. HB and thyroid cartilage covered the carotid sheath as preoperative 3D-CTA showed.

Hyoid larynx complex anomalies sometimes cause Eagle's syndrome (styloid process), hyoid syndrome^{5,6)} (HB), and superior thyroid cornu syndrome^{7,8)} (SHTC). The latter two syndromes occur infrequently, and acute cerebrovascular syndrome (ACVS) due to HB or thyroid cartilage misplacement is extremely rare and relatively unknown to clinicians. Two cases of ACVS resulting from misplacement of SHTC have been reported previously. In the first case, the patient suffered from symptomatic carotid stenosis caused by repetitive mechanical stimulation by the thyroid cartilage and received antiplatelet therapy only.⁹⁾ In the other case, the patient suffered from symptomatic severe stenosis of the vertebral artery caused by abnormal positioning of the SHTC, and the SHTC was removed in an operation.¹⁰⁾ We found that 17 ACVS cases due to HB obstruction have been reported previously. Among these reports, we summarized cases in which we identified the running course of the ICA (medial or lateral to ECA) and the positional relationship between HB and ICA^{1,11–22)} (Table 1). Among 14 cases, seven cases had twisted carotid bifurcations, and in all the cases the greater horn

of HB was located lateral to the ICA. On the contrary, in the cases of ICA running laterally (normal bifurcation), all the greater horn of HB was positioned medial to ICA normally. From this result it seems that this lateral positioning of HB is related to twisted carotid bifurcation, but the cause is unknown. In addition, some of these positional anomalies have been reported to be reversible changes. Some studies have reported that abnormal ICA position became normal (including its relationship with ECA^{1,15)} or HB¹¹⁾), or conversely, a normal positioning became abnormal²²⁾ naturally during follow-up period. There are other reports in which authors detected these changes by ultrasonography and then established a relationship between ICA and HB affecting swallowing²³⁾ or neck rotation.²⁴⁾ From these reports, there seem to be cases in which the structures of the HB and carotid bifurcation are more flexible than expected, and cerebral infarction due to mechanical stimulation by the hyoid–larynx complex may potentially be more common. In the present case, we did not detect an indentation of carotid artery by the greater horn of HB or the SHTC

Table 1 Summary of ACVS caused by HB

| Case | Author, references | Age/sex | Form of onset | TCB or normal at onset | Side | HB position relative to ICA | Natural repositioning (ICA-ECA/CA-HB) | Resection of HB | Surgical manipulation to CA | Operative complication |
|------|---------------------------------------|---------|-------------------|------------------------|------|-----------------------------|---------------------------------------|--------------------------|--|------------------------|
| 1 | Kawahara et al. ¹¹⁾ | 79/F | CI | TCB | Rt | Lateral | -/+ | - | CEA | - |
| 2 | Kawahara et al. ¹¹⁾ | 65/M | TIA | TCB | Rt | Lateral | -/+ | - | CEA | - |
| 3 | Liu et al. ¹²⁾ | 81/M | CI | TCB | Rt | Lateral | N.A./- | - | CEA patch | - |
| 4 | Martinelli et al. ¹³⁾ | 68/F | TIA | TCB | Rt | Lateral | N.A./- | - | CEA | - |
| 5 | Kölbel et al. ¹⁴⁾ | 61/F | CI | TCB | Rt | Lateral | N.A./- | + | - | Dysphagia (3 months) |
| 6 | Tokunaga et al. ¹⁾ | 46/F | CI | TCB | Rt | Lateral | +/- | + | CEA | - |
| 7 | Kho et al. ¹⁵⁾ | 29/F | CI | TCB | Lt | Lateral | +/N.A. | + | - | - |
| 8 | Schneider and Kortmann ¹⁶⁾ | 47/M | Pseudoaneurysm | Normal | Lt | Medial | N.A./N.A. | + | Lesion resection + end to end anastomosis of CCA | - |
| 9 | Hong et al. ¹⁷⁾ | 56/M | CI | Normal | Rt | Medial | -/- | + | - | - |
| 10 | Campos et al. ¹⁸⁾ | 29/M | CI | Normal | Rt | Medial | N.A./N.A. | + | Lesion resection + ECA-ICA bypass | - |
| 11 | Mori et al. ¹⁹⁾ | 61/M | CI | Normal | Lt | Medial | N.A./N.A. | - (technical difficulty) | Adhesionectomy + patch | - |
| 12 | Yukawa et al. ²⁰⁾ | 36/M | CI/dissection | Normal | Rt | Medial | N.A./N.A. | Medication | Medication | - |
| 13 | Renard and Freitag ²¹⁾ | 83/M | CI | Normal | Lt | Medial | N.A./N.A. | Medication | Medication | - |
| 14 | Renard et al. ²²⁾ | 30/M | CI/ICA dissection | Normal | Rt | Medial | +/+ | Observation | Observation | - |

CA: carotid artery, CCA: common carotid artery, CEA: carotid endarterectomy, CI: cerebral infarction, ECA: external carotid artery, F: female, HB: hyoid bone, ICA: internal carotid artery, Lt: left, M: male, N.A.: data were not available, Rt: right, TCB: twisted carotid bifurcation, TIA: transient ischemic attack.

in preoperative study nor in the operation. However, we experienced that twisted carotid bifurcation naturally became normal bifurcation. Repetitive mechanical stimulation following neck rotation could be one of the causes of carotid stenosis.

Finally, we discuss the risk of removing HB or SHTC. Considering anatomy, the greater horn of HB and SHTC has attached muscle groups that act during swallowing, and therefore massive resection of these structures may cause dysphagia. Close attention must be focused on the superior thyroid artery and vein, as damage of these structures can lead to immediate or late onset hematoma,²⁵⁾ and superior laryngeal nerve injury can cause weakness, tightness, and increased effort to speak.²⁶⁾ In the present case, the patient suffered transient swallowing discomfort after resection of the cartilage. There was no vocal cord paralysis, so we think there was no nerve injury or muscle injury but rather focal swelling around the manipulation site. The six cases in Table 1 received resection of HB and one of them had transient dysphagia.¹⁴⁾ We also included reports from otorhinolaryngology in our investigation, and no other reports showed postoperative deficit after removal of the greater horn of HB and SHTC. Hence, we think the greater horn of HB and SHTC can be removed relatively safely.

Conclusion

We performed the removal of the SHTC during CEA. Clinicians should be aware that hyoid–larynx complex anomalies occur at a relatively high rate, and they may obstruct the surgical corridor and cause several symptoms including ACVS.

Conflicts of Interest Disclosure

The authors do not have any disclosures or conflicts of interest to declare.

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Corresponding author: Takayuki Ishikawa, MD, PhD
Department of Neurosurgery, Ichinomiya Municipal
Hospital, 2-2-22 Bunkyo, Ichinomiya, Aichi 491-8558,
Japan.
e-mail: takazxrstcr@gmail.com