

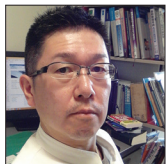
Case Report

Unusual course of the vagus nerve passing anterior to the internal carotid artery during carotid endarterectomy

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ABSTRACT

Background: Carotid endarterectomy (CEA) is a conventional surgical technique to prevent ischemic stroke and the effectiveness for advanced lesions is established in many large studies. The vagus nerve is one of the cranial nerves that we usually encounter during CEA manipulation, which is identified as located posterior to the vessels in a position posterolateral to the carotid artery and posteromedial to the internal jugular vein.

Case Description: We experienced an extremely rare case of the vagus nerve passing anterior to the internal carotid artery during CEA.

Conclusion: We should be careful not to accidentally cut off because the variation of the vagus nerve can be mistaken for an ansa cervicalis. A delicate and complete dissection to understand the variation of the vagus nerve is crucial to minimize the risk of cranial nerve injury during CEA.

Keywords: Anterior course, Carotid endarterectomy, Internal carotid artery, Vagus nerve

INTRODUCTION

Carotid endarterectomy (CEA) is a conventional surgical technique to prevent ischemic stroke and the effectiveness for advanced lesions is established in many large studies. Complications following CEA involve stroke, myocardial infarction, death, and cranial nerve injury. It is important to understand the anatomy of the vessels and cranial nerves. The vagus nerve is one of the cranial nerves that we usually encounter during CEA manipulation, which is identified as located posterior to the vessels in a position posterolateral to the carotid artery and posteromedial to the internal jugular vein (IJV).^[1-5]

We experienced an extremely rare case of the vagus nerve passing anterior to the internal carotid artery (ICA) during CEA.

CASE REPORT

A 74-year-old man, right-handed with hyperlipidemia had a carotid ultrasonography at a rural clinic and bilateral carotid artery stenosis was pointed out. The patient underwent CEA on the

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left side 6 months ago, and he was hospitalized to our hospital again for the purpose of CEA on the right side. The carotid artery stenosis was asymptomatic and he had no neurological deficit. Magnetic resonance angiography (MRA) revealed mild stenosis with white plaque at the origin of the right ICA [Figure 1a]. MR plaque imaging (T1-weighted fat suppression black blood) demonstrated a high intensity [Figure 1b and c]. These preoperative radiological findings suggested soft plaque. Three-dimensional computed tomographic angiography (CTA) suspected ulcer formation [Figure 1d], and a sagittal CTA maximum intensity projection image demonstrated a carotid web lesion [Figure 1e]. The patient underwent CEA under the endonasal intubated general anesthesia. The skin was incised along the anterior edge of the sternocleidomastoid muscle. The platysma was cut and the connective tissue was dissected delicately. By retracting sternocleidomastoid muscle and IJV, we exposed the carotid arteries. We used lone star retractor system (LSRS, Yufu Itonaga Co., Ltd., Tokyo) to get a shallower surgical field. The carotid sheath was cut and the vagus nerve was identified within major neurovascular bundle, which is described as located posterior the vessels in a position posterolateral to the common carotid artery (CCA) and posteromedial to the IJV. An ansa cervicalis was identified more laterally and preserved. By further dissecting the distal ICA and retracting of the digastric muscle, we identified the hypoglossal nerve. At that time, we encountered the vagus nerve passing anterior to the ICA [Figure 2a and b]. It crossed anterior to the ICA and went up beneath the hypoglossal nerve. It

unquestionably interrupted the clamp of distal ICA and arteriotomy. Therefore, we performed the clamp of distal ICA and arteriotomy by moderate towing the vagus nerve with silicon tape [Figure 2c and d]. The vulnerable plaque associated with a shelf [Figure 2e] was excised intact. Postoperatively, the patient had no new neurological deficit and discharged uneventfully.

DISCUSSION

The effectiveness of CEA for advanced carotid stenosis has been established in many large studies, and CEA is the gold standard in surgical treatment. Avoidance of perioperative complications in CEA is very important to maintain the effectiveness. The major complication rates of CEA examined usually involve stroke, myocardial infarction, and death. Cranial nerve injuries are usually considered minor complications. Cranial nerve injury can be usually caused by direct trauma to the nerve by retraction, stretch, dissecting, excessive manipulation of the carotid sheath, the clamp, or bipolar coagulation. The most common cranial nerve injury following CEA was reported to involve hypoglossal nerve and the second is variably reported in the literature as facial nerve or vagus nerve.^[1] The clinical manifestations due to vagal nerve injury including recurrent pharyngeal nerve, superior pharyngeal nerve, and the vagus trunk range from mild symptoms of hoarseness and loss of effective cough mechanism, to upper pharyngeal dysphagia with aspiration, to life-threatening airway obstruction from bilateral recurrent pharyngeal nerve injury.

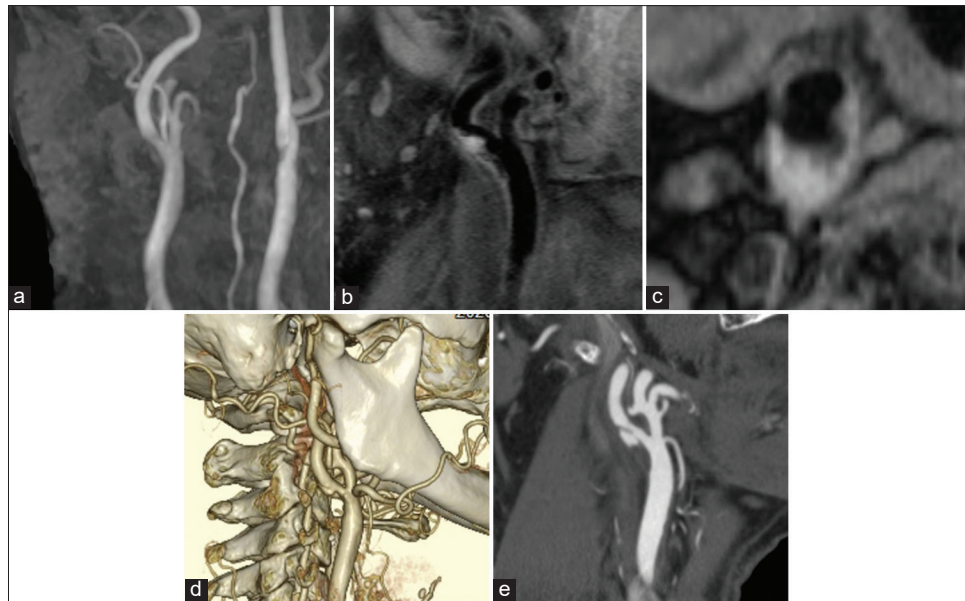


Figure 1: (a) Magnetic resonance (MR) angiography revealing mild stenosis with white plaque at the origin of the right internal carotid artery (ICA). (b and c) MR plaque imaging (T1-weighted fat suppression black blood) revealing a high-intense (b; sagittal, c; axial). (d) Three-dimensional computed tomographic angiography (CTA) revealing mild stenosis with ulcer formation at the origin of the ICA. (e) A sagittal CTA maximum intensity projection image demonstrating a carotid web lesion.

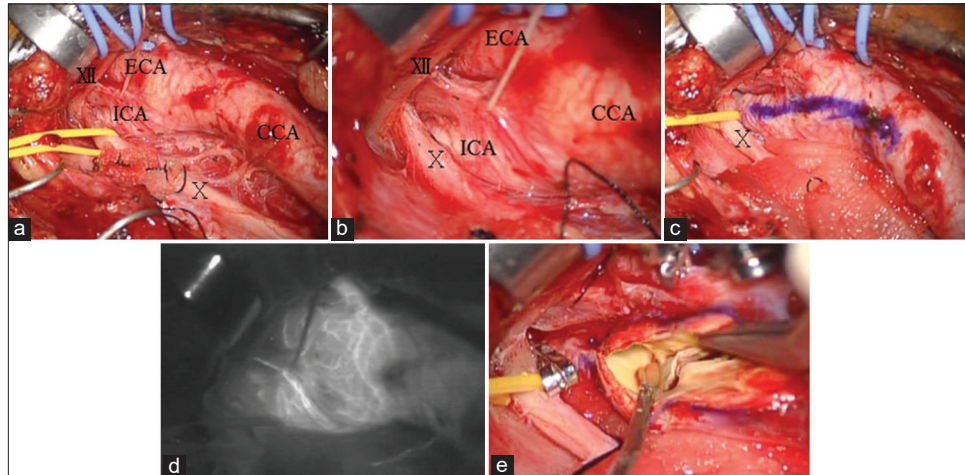


Figure 2: (a and b) An operative photograph demonstrating an unusual course of the vagus nerve passing anterior to the ICA. The internal jugular vein is retracted laterally. (c) The vagus nerve is moderately towed laterally with yellow silicone tape. An arteriotomy line is marked with Pyoktanin Blue. (d) The indocyanine green video angiography revealing vasa vasorum. (e) Lateral towing the vagus nerve with silicon tape has made the clamp of distal ICA and arteriotomy easier. X: Vagus nerve, XII; Hypoglossal nerve, CCA: Common carotid artery, ICA: Internal carotid artery, ECA: External carotid artery.

The vagus nerve exits the skull through the jugular foramen and it has a relatively straight course up to the thorax. It can be identified within the carotid sheath between the ICA and the CCA and the IJV in the neck, which is described as located posterior the vessels in a position posterolateral to the artery and posteromedial to the vein.^[2-5] Variations of the cervical course of the vagus nerve are possible but rare because this configuration has been quite stable. A course of the vagus nerve anterior to the carotid artery is reported with varying incidence from 0.7% to 5.5%.^[2-5] In a sonographic study reported this variation in 0.7% and only on the left side.^[2] In an another sonographic study reported that two variations (anterior and medial) were observed in 5.5% and the anterior variation was more common than the medial variation.^[5] AbuRahma and Choueiri reported that the anterior vagus course during CEA can be founded in <5% of the patients.^[1] On the other hand, some previous reports describe asymmetry between the vagus nerve, CCA, and IJV both at the right and left sides.^[4] Embryologically, during 12–15 weeks of gestation, the vagus nerve shifted to its position to the artery and vein from anterior, through intermediate, to posterior position, which is its definite position in adults. This shifting corresponds to increasing in the thickness of CCA which can be a possible reason for this position changes.^[3] Another possible reason can be migrating upwards of sympathetic ganglia together with inferior vagal ganglion, producing dorsal traction. However, on the left side, this process lags, in some cases the nerve stays anteriorly. These aforementioned facts can explain the anterior course of the vagus nerve an imperfect posterior shifting, more often on the left side.^[3] In the present case, on the one hand, the vagus nerve was normal in its course at a time of CEA on the left

side, but on the other hand, we had an extremely rare case of the vagus nerve passing anterior to ICA on the right side.

Delicate dissection and prompt knowledge of cranial nerve tracts, their relations with surrounding structures and anatomical variations are fundamental steps for preventing cranial nerve injury during CEA.^[1] We should be careful not to accidentally cut off because it can be mistaken for an ansa cervicalis. The most important thing in CEA is the deployment of the appropriate surgical field. The retractor system is an important device for the safe and smooth surgical manipulation in CEA, and making a shallower surgical field is very important. We prefer to use LSRS, which provides the usability to handle and a shallower surgical field compared with traditional retractors, and it can facilitate exposure of the distal ICA. This system consists of a frame and some hooks called elastic stay. The surgeon can retract with elastic stays easily to handle and safely while looking at the microscope.

CONCLUSION

We experienced an extremely rare case of the vagus nerve passing anterior to the ICA during CEA. A delicate and complete dissection to understand the variation of the vagus nerve is crucial to minimize the risk of cranial nerve injury during CEA.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. AbuRahma AF, Choueiri MA. Cranial and cervical nerve injuries after repeat carotid endarterectomy. *J Vasc Surg* 2000;32:649-54.

2. Giovagnorio F, Martinoli C. Sonography of the cervical vagus nerve: Normal appearance and abnormal findings. *AJR Am J Roentgenol* 2001;176:745-9.
3. Gradev A, Angelov AK, Dragolov M, Shahin TI, Jeleu L. Unusual course of the vagus nerve in the neck passing anterior to the common carotid artery. *Int J Anat Var* 2020;13:15-6.
4. Hojaij F, Rebelo G, Akamatsu F, Andrade M, Camargo C, Cernea C, *et al.* Syntopy of vagus nerve in the carotid sheath: A dissectional study of 50 cadavers. *Laryngoscope Investig Otolaryngol* 2019;4:319-22.
5. Park JK, Jeong SY, Lee JH, Lim GC, Chang JW. Variations in the course of the cervical vagus nerve on thyroid ultrasonography. *AJNR Am J Neuroradiol* 2011;32:1178-81.

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