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Case Report

Dynamic 3D-CT angiography during swallowing for diagnosing hyoid bone or thyroid cartilage compression-induced thromboembolism ☆,☆☆

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ABSTRACT

A 76-year-old man was admitted because of visual loss in his right eye, and was diagnosed with central retinal artery occlusion. Brain MRI revealed asymptomatic acute infarctions in the right middle cerebral artery territory. The proximal right internal carotid artery had migrated into a retropharyngeal location, presenting a 50% stenosis with calcified plaques, and was compressed by the hyoid bone and thyroid cartilage during swallowing on dynamic 3D-CT angiography. Partial resection of the hyoid bone and thyroid cartilage was performed and the postoperative course was uneventful. This case supports the utility of dynamic 3D-CT angiography during swallowing for diagnosing hyoid bone or thyroid cartilage compression-induced thromboembolism.

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Introduction

Mechanical compression of the internal carotid artery (ICA) by the hyoid bone is a rare cause of embolic stroke, retinal ischemia, and ICA atherosclerosis. [1–7] The mechanism of thrombus embolism involves thrombus formation caused by mechanical stress with endothelial injury and subsequent atherosclerotic plaques. [6–9] These ischemic events have been reported regardless of the presence of carotid artery stenosis. Furthermore, mechanical compression of the ICA by the hyoid bone was reported as a risk factor for atherosclerosis, ICA dissection, [10,11] and pseudoaneurysm formation. [12]

Regardless of the clinical importance of mechanical compression of the ICA by the hyoid bone, diagnosis can be challenging. Swallowing is considered a key mechanism underlying this mechanical compression, and carotid ultrasonography is useful for evaluating dynamic movement

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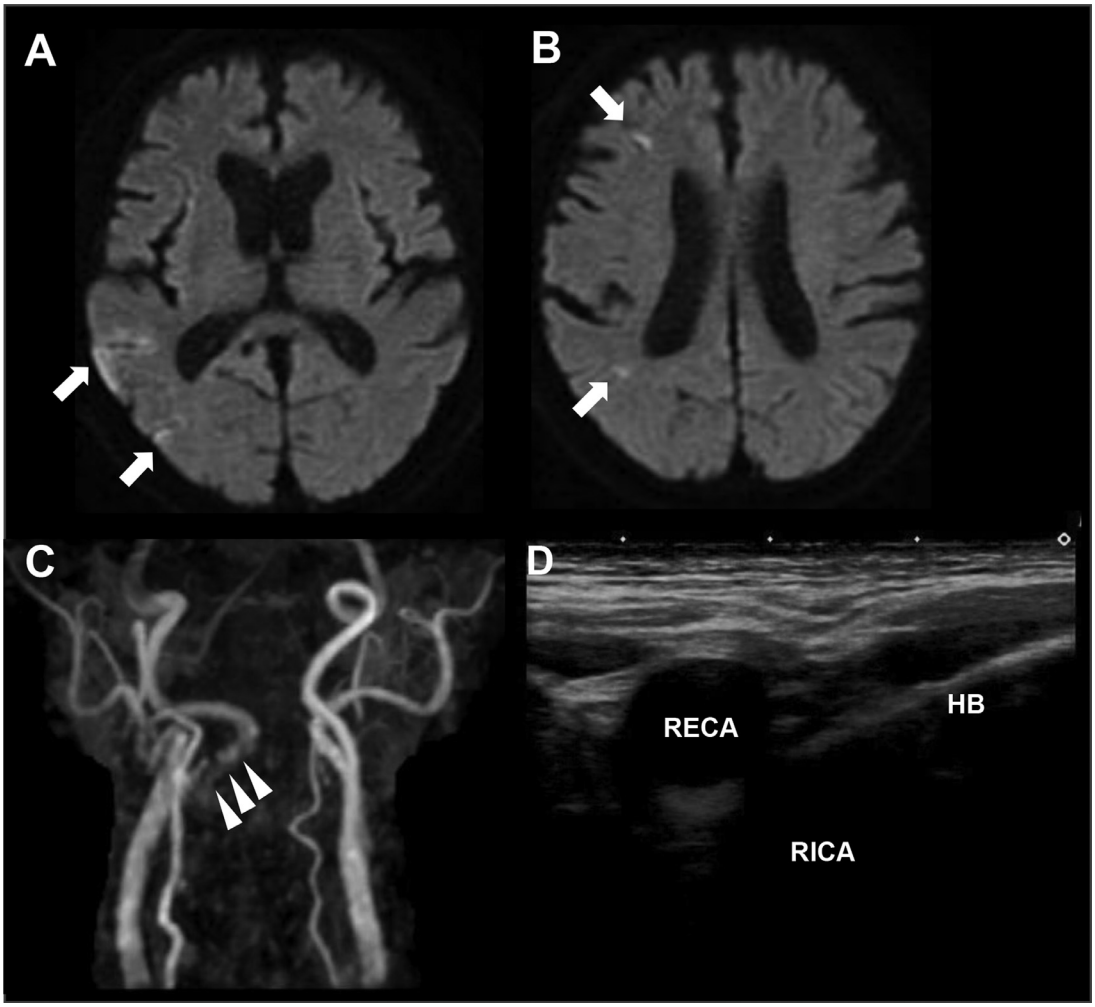

Fig. 1 – Brain and cervical magnetic resonance imaging on admission. Diffusion-weighted images showing high intensities in the territory of the right middle cerebral artery (A, B, arrows). Cervical magnetic resonance angiography showing tortuosity of the right proximal internal carotid artery running medially into a retropharyngeal location (C, arrowheads). On transverse B-mode imaging of carotid ultrasonography, the proximal right internal carotid artery (RICA) was not visualized because of the acoustic shadow from the hyoid bone (D). HB, hyoid bone; RECA, right external carotid artery.

of the ICA and hyoid bone during swallowing. [1–3,7] However, carotid ultrasonography is an operator-dependent modality, and requires technical training. Furthermore, it can be difficult to clearly visualize the proximal ICA on ultrasonography because of acoustic shadow from the hyoid bone. Although 3-dimensional computed tomography angiography (3D-CTA) is useful for determining the anatomical relationship of the ICA with surrounding tissues, it is static and lacks dynamic information. Herein, we report a unique case of embolic retinal and brain ischemia caused by compression of the ICA by the hyoid bone and thyroid cartilage, diagnosed with dynamic 3D-CTA during swallowing.

Case Report

A 76-year-old man was admitted to our hospital because of visual loss in his right eye after his breakfast. He had a medical history of cerebral embolism in the territory of his right middle cerebral artery 4 years prior, and was treated with aspirin to prevent ischemic stroke. Ophthalmic examination diagnosed central retinal artery occlusion. Brain magnetic resonance imaging revealed asymptomatic acute ischemic lesions in the territory of the right middle cerebral artery (Fig. 1A, B). Thus, he was suspected of having embolic retinal and brain ischemia, and was treated with antithrombotic therapy (aspirin, clopidogrel, and argatroban). Magnetic resonance angiography showed tortuosity of the right proximal ICA, migrating medially into a retropharyngeal location (Fig. 1C). On carotid ultrasonography, the proximal right ICA was not visualized because of the acoustic shadow from the hyoid bone (Fig. 1D). 3D-CTA revealed a stenosis of 50% with calcified plaques in the proximal right ICA (Fig. 2A). The right proximal ICA was also close to the right greater horn of the hyoid bone and superior horn of the thyroid cartilage (Fig. 2B, C). Anatomical anomalies of the hyoid bone or thyroid cartilage, such as elongation of the greater horn, [13] were not seen. Because we suspected mechanical compression of the

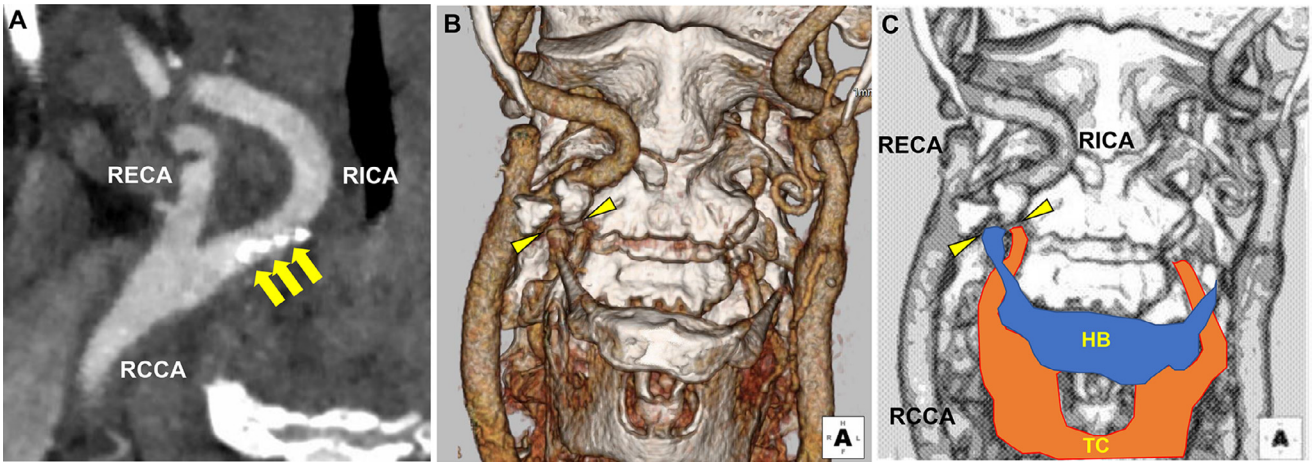

Fig. 2 – Three-dimensional computed tomography angiography of the cervical arteries. Multi-planar reconstruction showed a stenosis of approximately 50% at the proximal right internal carotid artery (RICA) with calcified plaques (A, arrows). Calcified plaques in the proximal RICA were close to the right greater horn of the hyoid bone and the superior horn of the thyroid cartilage (B, C [schema], arrowheads). HB, hyoid bone; RCCA, right common carotid artery; RECA, right external carotid artery; TC: thyroid cartilage.

right ICA by the hyoid bone and thyroid cartilage during swallowing, we examined dynamic 3D-CTA during swallowing. The protocol for dynamic 3D-CTA is described in the Supplementary file 1. On dynamic 3D-CTA during the swallowing movement, the ICA was first mildly shifted laterally because of compression of the anterior wall by superior movement of the hyoid bone and thyroid cartilage, and then abruptly shifted to the inside just after detachment of the hyoid bone and thyroid cartilage (Supplementary file 2, video). Dynamic multiplanar reconstruction images of the CTA showed a bone compression of the right ICA by the right greater horn of the hyoid bone and the right superior horn of the thyroid cartilage during swallowing (Supplementary file 3, video).

Other examinations including transthoracic echocardiography and 24 h Holter electrocardiography showed no evidence of embolic sources. Because we considered the mechanical compression of the right ICA by the hyoid bone and thyroid cartilage as a cause of embolic stroke and retinal ischemia in this case, partial resection of the right greater horn of the hyoid bone and the right superior horn of the thyroid cartilage was performed by otolaryngologists on day 35 (Fig. 3). The postoperative course was uneventful, and the patient was maintained on antithrombotic therapy with aspirin. Dynamic 3D-CTA and multiplanar reconstruction images on day 50 showed no compression of the right ICA by the hyoid bone and thyroid cartilage (Fig. 4 and Supplemental file 4, 5, video). He has had no recurrent events.

Discussion

We present a case report of embolic retinal and brain ischemia caused by mechanical compression of the ICA by the hyoid bone and thyroid cartilage, diagnosed with dynamic 3D-CTA during swallowing. As with previous reports of ischemic stroke associated with hyoid bone compression, [1,4,8,9] surgical treatment was performed with an uneventful postoperative course.

The proximal ICA usually runs laterally after bifurcation of the common CA. By contrast, in the present case the proximal right ICA ran into a retropharyngeal location. This anatomical variation of the ICA is termed a “retropharyngeal carotid artery,” [14] which is mainly caused by aging and atherosclerosis, with a prevalence of 2.6%. [14] Because there were no other anatomical variations in our case, such as elongation of the greater horn of the hyoid bone [13] or the superior horn of the thyroid cartilage, the characteristic retropharyngeal carotid artery caused the ICA to be in closer proximity to the hyoid bone of the thyroid cartilage. The retropharyngeal carotid artery was described in previous cases of brain ischemia associated with hyoid bone compression. [4,9]

In addition to the retropharyngeal carotid artery, in our case, swallowing contributed to mechanical compression of the right ICA by the hyoid bone and thyroid cartilage. At pharyngeal contraction at swallowing, the suprahyoid and thyrohyoid muscles move the hyoid bone in an anterosuperior direction, and the para-and retropharyngeal spaces (including the ICA and external carotid artery) are usually drawn in anterointernally. [15] However, the ICA is first mildly shifted laterally because of the collision with the hyoid bone and thyroid cartilage. We considered that the repetitive mechanical compression during swallowing by the hyoid bone and thyroid cartilage caused shear stress in the arterial wall, endothelial damage, atherosclerosis, and subsequent thromboembolism in our case.

A distinctive feature of the present case was that the compression of the ICA by the hyoid bone and thyroid cartilage during swallowing was visualized by dynamic 3D-CTA. In previous cases of hyoid bone compression-induced thromboembolism, the compression of the ICA by the hyoid was demonstrated by 3D-CTA, [4–6,9] cerebral angiography, [6] and

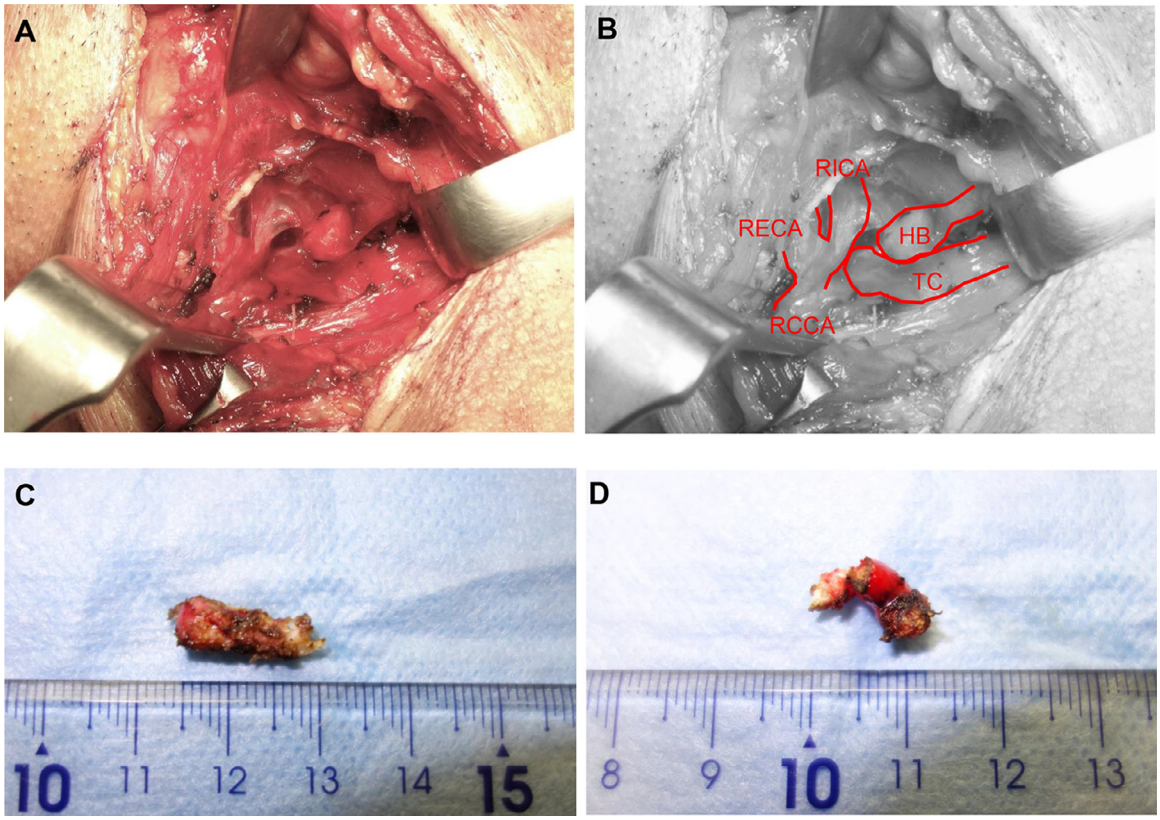

Fig. 3 – Intraoperative view (A, B [schema]) and resected right greater horn of the hyoid bone (C) and right superior horn of the thyroid cartilage (D). HB, hyoid bone; RCCA, right common carotid artery; RECA, right external carotid artery; RICA, right internal carotid artery; TC, thyroid cartilage.

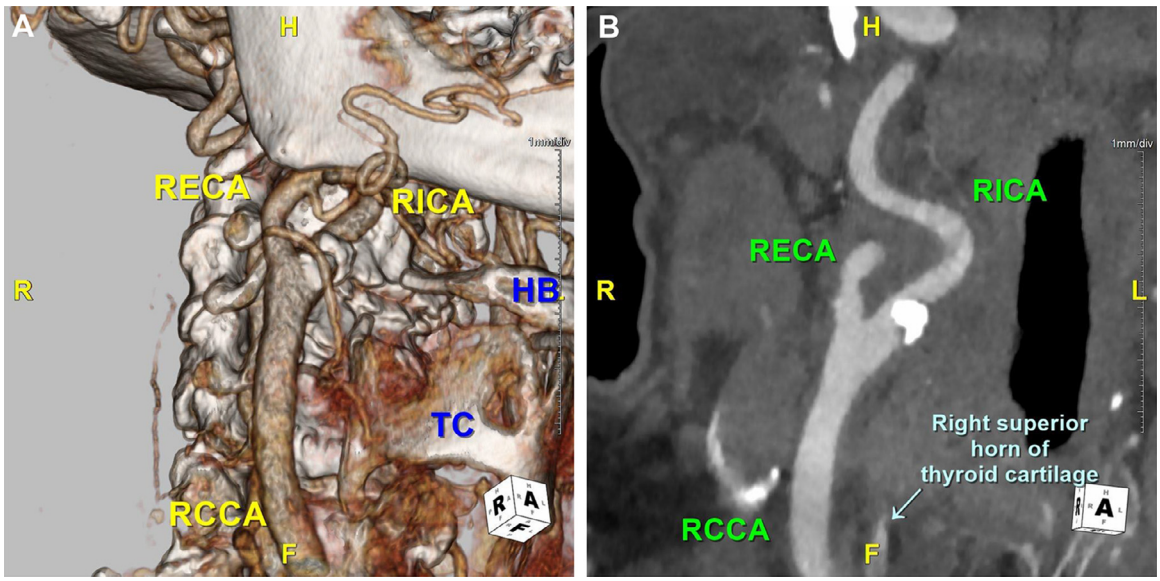

Fig. 4 – Postoperative three-dimensional computed tomography angiography (3D-CTA) of the cervical arteries (A) and multiplanar reconstruction image of the 3D-CTA (B). HB, hyoid bone; RCCA, right common carotid artery; RECA, right external carotid artery; TC: thyroid cartilage.

carotid ultrasonography. [1,5] Although 3D-CTA revealed that the right ICA was close to the hyoid bone and the thyroid cartilage in our case, it lacks dynamic evaluation. Thus, mechanical compression of the right ICA during swallowing cannot be assessed. In cases with mechanical compression of the ICA evoked by swallowing, as in our case, the compression may not be precisely visualized without dynamic modalities during swallowing. Carotid ultrasonography is useful for evaluating dynamic movement of the ICA and hyoid bone during swallowing. [1–3,7] However, it was difficult to clearly visualize the ICA on ultrasonography in the presence of acoustic shadow from the hyoid bone in our case. Dynamic 3D-CTA during swallowing may be useful for understanding the dynamic anatomical relationship of the carotid arteries with surrounding structures during swallowing.

Conclusion

We present a case of retinal and brain ischemia caused by mechanical compression of the ICA by the hyoid bone and thyroid cartilage evoked by swallowing. This case supports the utility of dynamic 3D-CTA during swallowing for diagnosing hyoid bone or thyroid cartilage compression-induced thromboembolism.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2020.06.016.

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