Intrathoracic bifurcation of the right common carotid artery

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SUMMARY

Intrathoracic carotid artery bifurcation is a very rare condition and only six cases have been reported to the best of our knowledge. We present a case of a 52-year-old man who was found to have an atretic intrathoracic internal carotid originating at the T3 level. The recognition of an intrathoracic carotid bifurcation is essential in the planning of thoracic and vascular procedures to avoid unintentional iatrogenic injuries.

BACKGROUND

The level of common carotid artery (CCA) bifurcation most commonly occurs at C3–C5. The CCA may bifurcate at higher or lower cervical levels; high bifurcations are far much more common.^{1–4} However, intrathoracic bifurcation of the common carotid is very rare and only six cases have been reported in the literature.^{2–3–5}

We report the case of a 52-year-old man who was found to have intrathoracic bifurcation of the right CCA at the level of T3. Knowledge of potential anatomic variants is of significant importance in planning of surgical procedures of the head, neck and cervical spine. In particular, in the setting of carotid stenosis, intrathoracic bifurcation of the CCA would preclude carotid endarterectomy.^{1–4}

CASE PRESENTATION

A 52-year-old man with medical history of hypertension and cervical spinal stenosis status postanterior plate and screw fixation of C5 through C7 was referred to the radiological department for evaluation of carotid stenosis. The patient complained of dizziness and a vascular carotid duplex was ordered. The ultrasound was unable to identify bifurcation of the carotid artery on the right side, but the right internal and external carotids were visualised on the neck region. The peak flows of the internal carotid demonstrated a patent system with only mild stenosis of both right and left internal carotid. Since the patient remained symptomatic, a CT angiogram of the head and neck was performed for further evaluation. This study showed an aberrant origin of the right internal carotid artery arising below the thoracic inlet at the T3 level immediately above the brachiocephalic artery bifurcation (figures 1 and 2). Moreover, it was noted that the right internal carotid was atretic and continued into the skull through a hypoplastic foramen lacerum and carotid canal. The carotid canal's diameter on the right side measured 4 mm and the left one was 8 mm (figure 3). No abnormalities were found on the right external carotid or its branches. The left common carotid and left

internal and external branches were grossly unremarkable.

Volume rendering images of the arteries on cerebral circulation showed variations on the right side. The right middle cerebral artery (MCA) appeared to receive predominant vascular supply from the posterior circulation via retrograde flow through a prominent posterior communicating artery. The right A2 segment of the anterior cerebral artery (ACA) appeared to receive predominant vascular supply from the left ACA through a patent anterior communicating artery. The A1 segment was not visualised on the right side. Cerebral circulation on the left side was unremarkable (figure 4). In addition, non-specific enlargement of the left globe was noted in the radiological study.

DISCUSSION

Anatomical knowledge of the level of bifurcation of the common carotid artery (CCA) is essential to minimise morbidity and mortality in patients undergoing carotid endarterectomy or invasive procedures such as angiography.^{2–4–6–8} Most studies state that the common carotid bifurcates at the level of the superior border of the thyroid cartilage which corresponds to C4–C5.^{2–4} Other dissertations describe CCA bifurcation at the tip of the greater horn of the hyoid bone, which is at C3.^{1–2–6–7} Hence, it is known that the most common level of bifurcation of CCA lies between C3 and C5 vertebral levels,² but higher levels (C1–C2) and lower levels (C6–C7) have also been encountered.^{1–2–4} Gailloud *et al.* reported that the frequency of bifurcation at C1–C2 and C6–C7 were 0.3% and 0.15% respectively.² Another study carried out in Singapore found that the right CCA bifurcated at C3 in 50% of patients and at C4 in 40% of cases.¹ However, intrathoracic bifurcation of the CCA is extremely rare with only six cases reported in the literature.^{2–3} Intrathoracic bifurcation has been noted between T1 and T3 and has mostly been associated with Klippel-Feil syndrome. This syndrome is characterised by a short-webbed neck, fusion of the cervical vertebral bodies, low posterior hairline, limited head motion, cervical stenosis, Sprengel's scapular deformity as well as brainstem, cardiac and genitourinary abnormalities.^{2–3–9–10} In the case of our patient, he had a history of prior cervical stenosis, but no congenital cervical fusion or other major criteria were met for the diagnosis of Klippel-Feil syndrome. Embryologically, low bifurcation of the common carotid has been related to the persistence of ductus caroticus, which is a segment of the dorsal aorta that connects the third and fourth aortic arches.²

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Figure 1 (A) Coronal view of CT angiogram showing right external and internal carotid arteries running separately in the neck. (B) In contrast, bifurcation of the left common carotid occurs in the cervical region. (C) Axial CT angiogram showing thoracic bifurcation of right common carotid (arrowhead). (D) Right internal carotid of diminished calibre (thick arrow) and right external carotid (thin arrow) are demonstrated.

Since intrathoracic bifurcation of the CCA can occur, caution is advised, when evaluating the cervical vasculature of these patients. Procedures such as an angiography carry a risk of unintentional internal carotid catheterisation because the CCA segment is usually short in these cases.^{2-4 7} Also, the removal of atheromatous plaques via routine carotid endarterectomy may be precluded with intrathoracic carotid bifurcation.^{2-4 6 7} Carotid stenting is considered to be the most appropriate alternative in patients with an aberrant intrathoracic origin of the internal carotid.^{2 3}

Our case in addition to having an intrathoracic bifurcation also demonstrated diminished calibre of the right internal carotid artery, whose intracranial contribution consisted primarily of vascular supply to the ophthalmic artery. Compensated intracranial circulation was observed with the right middle cerebral artery (MCA) receiving predominant supply via a

retrograde flow through the right posterior communicating artery. Similarly, the right A2 segment received predominant vascular supply from the left ACA through a patent anterior communicating artery.

Although intrathoracic bifurcation of the common carotid is not frequently seen, we present this case to stress the importance of a thorough knowledge of anatomic variations to avoid unnecessary complications when performing endovascular or surgical procedures in the carotid artery.

Figure 2 Volume rendering image demonstrating atretic right internal carotid and intrathoracic bifurcation of the right common carotid artery.

Figure 3 CT angiogram of head showing hypoplastic right carotid canal (thick arrow) measuring 4 mm in diameter. Thin arrow showing normal left carotid canal.

Figure 4 Volume rendering image demonstrating vascular supply of the right middle cerebral artery from posterior circulation via retrograde flow through the right posterior communicating artery. Also note vascular supply of the right anterior cerebral (A2 segment) from the left cerebral circulation through a patent anterior communicating artery.

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Learning points

- The bifurcation of the common carotid artery commonly occurs between the C3 and C5 vertebral levels. Higher and lower levels of bifurcation in the cervical region may be encountered.
- Intrathoracic bifurcation of the common carotid is very rare and only six cases have been reported in the literature.
- Recognition of the anatomical variants is essential in the planning of surgical procedures of the head, neck and cervical spine to avoid unintentional iatrogenic injuries.
- In the setting of intrathoracic internal carotid stenosis, carotid stenting is considered to be the most appropriate alternative for removal of atheromatous plaque.

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