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A Case of Color Doppler Ultrasound Diagnosis of Carotid Body Tumor

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Abstract: Carotid body tumor is a rare type of paraganglioma that occurs outside the sheath of the carotid artery, with a predilection for individuals aged 40 to 60, and an equal incidence in both men and women. Due to limited understanding of carotid body tumors, they are often missed or misdiagnosed on ultrasound examination. Although most carotid body tumors grow slowly, their special location in the neck, rich blood supply, and the difficulty of surgery, combined with a certain tendency for malignant transformation, have led to increasing clinical attention to carotid body tumors, making early diagnosis of vital clinical significance. This paper presents a retrospective analysis of a case of carotid body tumor, aiming to explore the diagnostic value of color Doppler ultrasound in the diagnosis of carotid body tumors.

Keywords: Color Doppler Ultrasound;Carotid Body Tumor;Clinical Significance

The patient is a 74-year-old female who noticed a lump on the left side of her neck for over a year. Recently, she has observed an increase in the size of the lump. There is no significant pain, occasional dizziness, and no hoarseness or cough. The preliminary clinical diagnosis is a pending investigation into the nature of the lump on the left side of the neck. In the specialized examination, bilateral carotid artery pulsation is present. A lump of approximately 3.0 cm× 4.0 cm in size is palpable below the left mandibular angle. It is still mobile, non-tender, pulsatile, and the skin sensation is normal.

Neck Color Doppler Ultrasound Examination: A solid hypoechoic mass is detected between the internal and external carotid arteries at the bifurcation of the left common carotid artery. The size is approximately 4.3 cm × 2.8 cm, with an irregular shape and a relatively clear border. Multiple anechoic areas are observed inside the mass, and it is closely related to the carotid artery. Color Doppler Flow Imaging (CDFI) shows abundant blood flow signals within the mass. The ultrasound suggests a carotid body tumor (see **Figure 1, Figure 2**).

Neck CTA Examination: At the bifurcation of the left carotid artery, a mass with regular borders and uneven density is observed. After contrast agent injection, the lesion shows uneven and significant enhancement, supplied by the external carotid artery. The angle

between the internal and external carotid arteries widens, and the tumor appears "globe-shaped" with a maximum cross-section of approximately 2.4 cm × 3.3 cm. The findings suggest a carotid body tumor (see **Figure 3, Figure 4**).

Figure 1: A round hypoechoic mass is visible at the bifurcation of the carotid artery

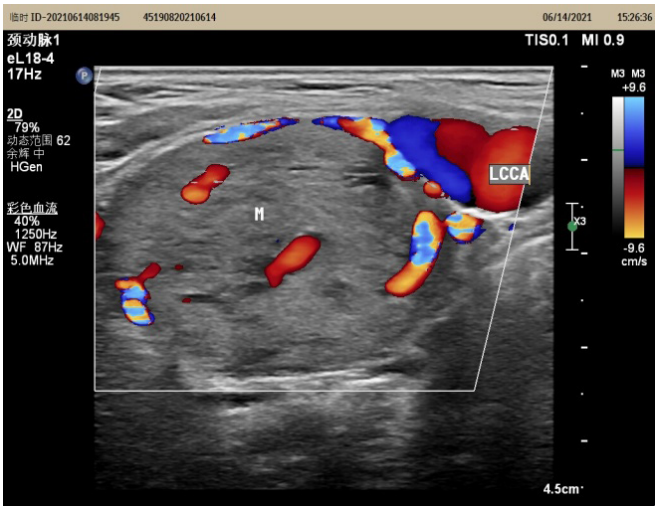

Figure 2: Color Doppler Flow Imaging (CDFI) shows abundant blood flow signals within the mass, and there is a noticeable widening of the angle at the bifurcation of the carotid artery

Figure 3, Figure 4: Neck CTA - Soft tissue mass is observed around the bifurcation of the left common carotid artery, enveloping the internal and external carotid arteries

Intraoperative Findings: An approximately 8cm oblique incision was made on the left side of the neck, extending from the anterior edge of the sternocleidomastoid muscle to behind the left ear. The surgery involved sequential dissection of the skin, subcutaneous tissue, and the sternocleidomastoid muscle. Careful separation of surrounding tissues revealed the left carotid sheath. A mass, approximately 3 cm × 3 cm in size, was observed at the bifurcation of the left common carotid artery. The mass had a soft texture, clear boundaries, and closely surrounded the internal and external carotid arteries as well as the surrounding nerves. The mass was excised successfully during the surgery.

Postoperative Pathology: (Left neck mass) Well-differentiated neuroendocrine tumor (NET, G1) without capsule involvement. Immunohistochemistry:

P-CK(-), CK7(-), TTF-1(-), NaspinA(-), TG(-), ER(-), PR(-), Ki-67(< 3%), EMA(-), S-100(-), HMB-45(-), Syn(diffuse+), CgA(diffuse+), CD56(diffuse+), CD20(-), CD3(-).

Special Stains: Masson(+), VG(+).

Discussion

Carotid body tumor (CBT) is an extremely rare paraganglioma. It originates from the carotid body, located at the bifurcation of the carotid artery, also known as a chemoreceptor tumor. It is the most common paraganglioma in the head and neck region, second only to jugulotympanic paraganglioma. Chronic hypoxia prompts the proliferation of the carotid body, and the initial symptom is often a painless neck mass. Nonspecific symptoms may include local tenderness in the neck, dizziness, and blurred vision, indicating manifestations of cerebral ischemia. Additionally, it may exhibit the activity of a neuroendocrine tumor. Although this tumor is benign, there is a potential risk of malignant transformation.

Carotid body tumors can occur at any age but are more common in individuals aged 40 to 60 years, with an equal incidence in both men and women. Approximately 90% of carotid body tumors are sporadic, while 10% are familial, and one-third of familial cases are bilateral[1]. There is evidence to suggest that chronic hypoxic conditions, such as chronic obstructive pulmonary disease (COPD) or living in high-altitude areas with chronic hypoxic exposure, may lead to hyperplasia, hypertrophy, and even tumor formation in the carotid bodies. Therefore, individuals with susceptibility to carotid body tumors due to genetic mutations may develop these tumors at an earlier age if exposed to chronic hypoxic stimuli.

Carotid body tumors are slow-growing pulsatile masses in the neck. When the tumor is small, it is typically asymptomatic. As the tumor enlarges, local symptoms such as localized pain, difficulty swallowing, hoarseness, jaw stiffness, pharyngitis, or numbness of the tongue may occur. With the tumor's growth, it often extends along the arterial wall, gradually enveloping the carotid bifurcation, common carotid artery, internal carotid artery, and external carotid artery. It tightly adheres to the arterial adventitia, making separation difficult[2]. Additionally, it may involve the vagus nerve or hypoglossal nerve, and auscultation may reveal a

murmur when pressure is applied to the carotid artery. Functional tumors can lead to elevated catecholamine secretion, resulting in symptoms such as hypertension, headache, and increased sweating. Although 20% of head and neck paragangliomas show malignant tendencies, carotid body tumors are often benign, with a malignancy rate ranging from 0 to 11.1%. Even in cases of metastasis, the tumors tend to metastasize to cervical lymph nodes rather than distant locations. Shamblin classified carotid body tumors into three categories based on tumor size and the extent of involvement with neck vessels:

(1) Type I: Tumor diameter < 4cm, not encircling the carotid artery.

(2) Type II: Tumor diameter > 4cm, encircling the carotid artery.

(3) Type III: Giant tumor, carotid artery bifurcation completely embedded within the tumor.

The ultrasound examination of the carotid body tumor reveals a circular solid lesion with uneven hypoechoic echoes at the level of the carotid artery bifurcation. The border of the tumor is clear, and there is an increased angle between the internal and external carotid arteries. Abundant blood flow is observed within the tumor. Ultrasound not only provides a clear display of the tumor's extent but also reveals the depth of the tumor invading the various layers of the vascular wall, allowing for the assessment of resectability. Ultrasound examinations are characterized by their accuracy, safety, reliability, and non-invasiveness. They can vividly display the morphology and characteristics of the tumor's blood supply. Compared to vascular imaging, ultrasound imaging is convenient for bedside examinations of carotid body tumor patients.

Differential diagnosis of carotid body tumors includes:

(1) Neurogenic Tumors: These tumors are often located superficially near large blood vessels in the neck. They do not encircle the vessels, may have cystic areas, exhibit relatively sparse blood flow, and there is no enlargement of the angle between the internal and external carotid arteries.

(2) Enlarged Lymph Nodes: Multiple enlarged lymph nodes, sometimes with visible lymph node hilum, are typically found superficially near blood vessels. They rarely encircle the vessels, and blood flow is relatively sparse.

(3) Carotid Aneurysm: True arterial aneurysms present as localized dilatations of the vascular lumen with thin or slightly thickened walls. In contrast, the vascular lumen surrounded by a carotid body tumor does not show dilatation. False arterial aneurysms manifest as localized thick-walled hematomas adjacent to the vascular lumen, communicating with the lumen similar to carotid body tumors[3]. However, the thickened wall in false aneurysms consists of fibrous tissue and lacks blood flow.

Carotid body tumors typically appear as isoattenuating or slightly hyperattenuating masses with clear borders on CT plain scans, showing a regular shape. On contrast-enhanced scans, the tumor demonstrates significant enhancement. Three-dimensional reconstruction techniques provide a visual representation of the relationship between the carotid arteries and the tumor in a more intuitive manner.

The definitive diagnosis of carotid body tumors is often achieved through selective bilateral cerebral angiography. The characteristic feature of the tumor is a multivascular, oval-shaped mass occupying the bifurcation of the carotid artery[4]. For larger tumors, preoperative embolization can be performed to reduce intraoperative bleeding or prepare for palliative radiotherapy.

Due to the highly vascular nature of carotid body tumors, incisional biopsy is not recommended as it may lead to significant bleeding or cranial nerve injury. Fine needle aspiration biopsy can be helpful when imaging diagnosis is unclear; however, the histological findings may not reliably predict the tumor's metastatic behavior.

The primary treatment for carotid body tumors is surgical excision. However, due to their rich blood supply, accurate preoperative assessment of the tumor's relationship with surrounding tissues is crucial. Without a precise evaluation, there is a risk of damaging blood vessels and nerves during surgery, leading to severe bleeding or even death. Therefore, preoperative assessment is essential for carotid body tumors. Common imaging studies used for evaluating carotid body tumors include ultrasound, CTA (computed tomography angiography), MRI (magnetic resonance imaging), and DSA (digital subtraction angiography). These various examinations complement each other and provide crucial reference information for clinical surgery.

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