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Case Report

Radiation-Induced Bilateral Carotid Artery Stenosis in a Post-Radiotherapy Tongue Cancer Patient: A Case Report

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Abstract: Carotid artery stenosis (CAS) is a significant cause of stroke, with common risk factors including advanced age, diabetes, coronary artery disease, smoking, and a history of stroke or transient ischemic attack (TIA). An often underrecognized cause is radiation-induced CAS, which can lead to serious complications. While radiotherapy plays a vital role in managing head and neck cancers, it may also damage blood vessels, leading to vascular disease.We report the case of a 71-year-old male with bilateral carotid stenosis secondary to prior radiotherapy, who presented with an acute left cortical infarct. ***Case Details*:** The patient arrived with sudden onset of left facial deviation and right-sided weakness, scoring an NIHSS of 8. He had a medical history of hypertension and tongue cancer, treated with chemotherapy and radiotherapy in 2019. MRI revealed an acute infarct in the left cerebral cortex. Cerebral digital subtraction angiography (DSA) showed 70% stenosis of the right internal carotid artery (ICA) and 90% stenosis of the left ICA. As he was outside the window for thrombolysis, conservative management was initiated, followed by left ICA stenting. Post-procedure, he showed good recovery and was discharged on dual antiplatelet therapy and statins. ***Discussion*:** Radiation-induced CAS occurs in approximately 25% of patients, with a cumulative 10-year risk exceeding 25%. The incidence varies depending on cancer type, and data specific to tongue carcinoma is limited. A study by Seto K *et al.*, reported only a 4% incidence in tongue cancer patients, underscoring the need for more research. The scarcity of data hampers early diagnosis and preventive care for radiation-associated CAS. ***Conclusion*:** Managing radiation-induced CAS is complex due to fibrosis and scarring in the neck region. This case highlights the importance of routine follow-up in patients with a history of head and neck radiotherapy. Carotid Doppler ultrasound may serve as an effective screening tool for early detection.

Keywords: Carotid Artery Stenosis, Radiation-Induced Vasculopathy, Tongue Carcinoma, Stroke, Carotid Stenting, Head and Neck Cancer.

INTRODUCTION

Stroke remains one of the leading causes of death and long-term disability in developed countries. Approximately 85% of all strokes are ischemic in nature, and nearly one-third of these are attributable to cervical carotid artery disease. The underlying mechanism of stroke in such cases may involve embolization from atherosclerotic plaques at the carotid bifurcation or hemodynamic compromise resulting from significant arterial narrowing. The risk of both embolic events and hemodynamic insufficiency increases with the degree of carotid artery stenosis [1–3].

Established independent predictors of significant carotid artery stenosis (defined as ≥50% luminal narrowing) include advanced age, diabetes mellitus, coronary artery disease, smoking, and a history of stroke or transient ischemic attack (TIA). However, radiation-induced carotid artery stenosis (RI-CAS) is an increasingly recognized yet underappreciated cause of significant cerebrovascular events.

With advancements in oncologic care, radiotherapy has become a cornerstone in the treatment of head and neck cancers. Despite its therapeutic benefits, radiation can have deleterious effects on the vascular system, leading to the development of radiation-induced vascular diseases. RI-CAS is a potentially life-threatening complication, with studies reporting its occurrence in 30% to 50% of patients who have undergone external beam irradiation for head and neck malignancies [4].

In this report, we present the case of a 71-year-old male who developed significant bilateral carotid artery stenosis following radiotherapy for tongue carcinoma, ultimately resulting in an acute left cortical infarct.

CASE DETAILS

A 71-year-old male presented with complaints of sudden onset deviation of the angle of the mouth to the left, right-sided weakness, and inability to get out of bed. He presented 7.5 hours after the onset of symptoms. On evaluation, his NIHSS was 8, and his baseline modified Rankin Scale (mRS) score was 2.

He had a past medical history of well-controlled hypertension and carcinoma of the base of the tongue, which was treated with chemotherapy and radiotherapy in 2019. In 2017, he had presented with odynophagia. A detailed evaluation at that time revealed Grade 3 squamous cell carcinoma of the base of the tongue with regional spread. He was treated with 3D conformal radiation therapy and received 70 Gy in 35 fractions of external beam radiotherapy over 8 weeks.

On examination, the patient had moderate dysarthria, mild right-sided facial weakness, reduced tone in the right upper and lower limbs, power of 3/5 in the right upper and lower limbs, and an extensor plantar response on the right side.

An immediate CT scan of the brain revealed an acute left cortical infarct (Fig 1 and 2). MRI of the brain with angiography of intracerebral vessels showed multifocal acute infarcts in the left corona radiata (Fig 3 and 4). However, the brain angiography study did not reveal any abnormalities (Fig 5 and 6).

Further investigations were conducted to determine the cause of the stroke. ECG showed normal sinus rhythm. Echocardiography did not reveal any regional wall motion abnormalities. The left atrial diameter was 3.2 cm, the left ventricular ejection fraction was 58%, and left ventricular concentric hypertrophy was noted.

Relevant blood investigations revealed:
Hemoglobin: 10.8 gm/dL
Total leukocyte count: 5800/cumm
Platelets: 1.58 lakhs/cumm
INR: 1.16
Serum creatinine: 0.7 mg/dL
Electrolytes and liver function tests: within normal limits
HbA1c: 5.6%
TSH: 2.4
Lipid profile: within normal range
A 24-hour Holter monitoring did not show any pauses or significant arrhythmias.

Given the patient's history of radiotherapy and the lack of other identifiable causes for the stroke, an MR angiography of the neck vessels was performed. It revealed severe narrowing of the left proximal internal carotid artery (ICA) immediately after its origin and a short segment narrowing of the right proximal ICA (Fig 6 and 7).

The patient then underwent cerebral digital subtraction angiography (DSA) under local anesthesia, which confirmed bilateral carotid artery stenosis. The right common carotid angiogram showed 70% stenosis of the right ICA at its origin, and the left CCA showed 90% stenosis of the left ICA (Fig 9 and 10).

As the patient had presented outside the thrombolysis window period, thrombolytic therapy was not administered. Considering the absence of significant comorbidities and the history of radiation therapy five years prior, post-radiation vasculopathy was considered a likely cause of the bilateral carotid stenosis.

The patient was started on dual antiplatelets, a statin, and supportive care. Given the marked bilateral stenosis, there was a high risk of future ischemic events, and an interventional procedure was deemed necessary.

The patient was planned for carotid artery stenting, which was performed under local anesthesia. Vascular access was secured via the right femoral artery. A guidewire was introduced, followed by the catheter (Fig 11 and 12). Balloon angioplasty was performed, followed by stent placement (Fig 13 and 14). Post-stent placement angiography showed good blood flow (Fig 15 and 16). The procedure was well tolerated, and the patient made a good recovery. He is currently on dual antiplatelets, a statin, and is under regular follow-up.

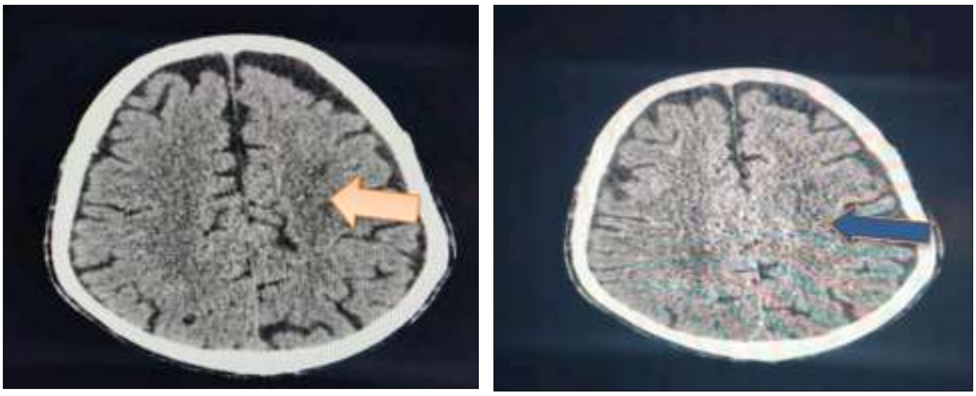

Fig. 1 & 2: CT Scan Showing Acute Left Cortical Infarct (Shown with orange and blue arrow)

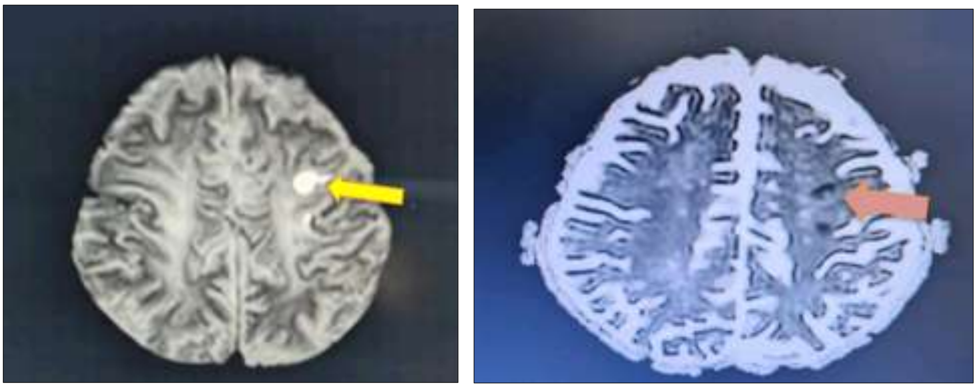

Fig. 3 & 4: Mri Brain Showing Dwi Restriction in Left Cortical Region Suggestive Multiple Acute Infarcts in Left Corona Radiata Infarct (With an Arrow Marked as Yellow and Pink)

Fig. 4 & 5: MRI Angiography of Brain Vessels Showing Normal Study

Fig. 6 & 7: MRI Angiography of Necks Vessels Showing Severe Stenosis of Left Proximal Ica Artery (Marked as Blue Arrow)

Fig. 8: Catheter Being Introduced for Cerebral Angiography

Fig. 9 & 10: Left CCA Angiogram Showing 90% Stenosis of Left Ica (Marked as Blue Arrow)

Fig. 11 & 12: Showing Angiography Images of Guide Wire Being Introduced and Catheter Being Introduced Over Guide Wire (Marked as Green Arrow)

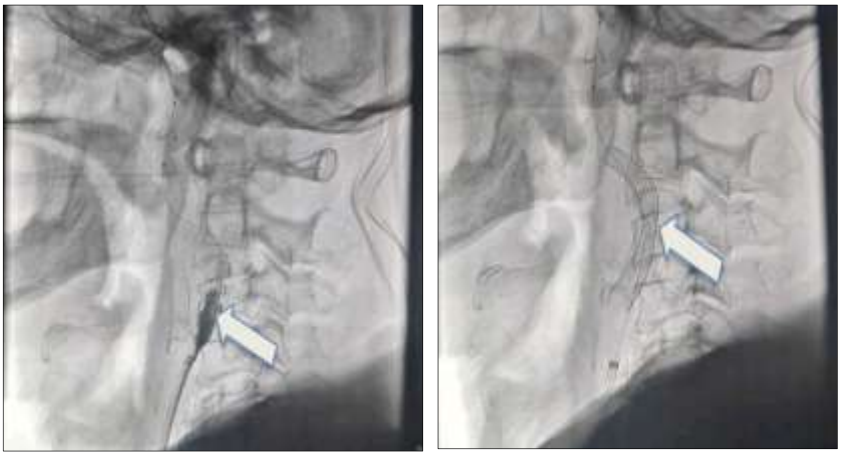

Fig. 13 & 14: Ballonplasty Done and Stent Placed (Marked as White Arrow)

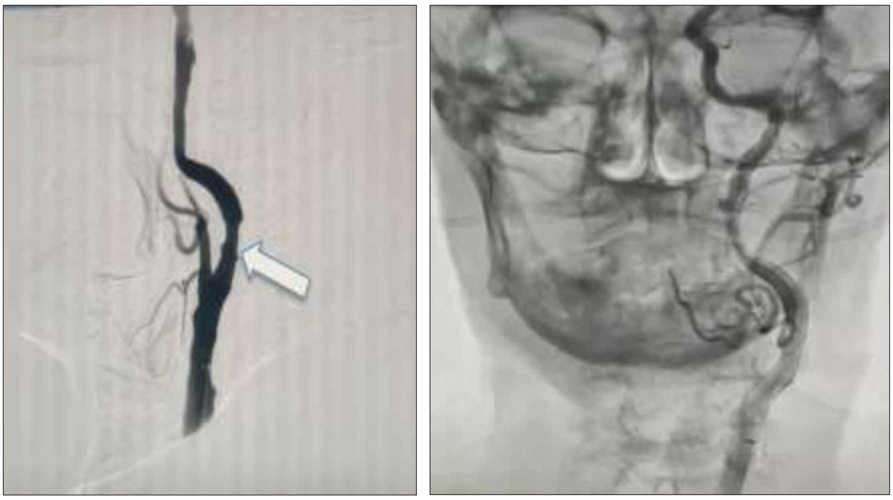

Fig. 15 &16: Good Blood Flow Obtained Post Stent Placement (Marked as White Arrow)

DISCUSSION

As physicians, it is imperative that we assess the true prevalence of radiation-induced carotid artery stenosis (CAS), which can help us implement preventive measures to avoid the major sequelae of this condition.

Lam *et al*., Conducted a study comparing extracranial carotid artery stenosis in pre- and post-radiation groups of patients with nasopharyngeal carcinoma. They concluded that the prevalence of extracranial artery disease was 78.9%, and stenosis of >50% was seen exclusively in the post-radiation group [5].

Zhou *et al*., Used contrast-enhanced magnetic resonance angiography (CE-MRA) to assess carotid and vertebral artery stenosis in nasopharyngeal carcinoma patients after radiotherapy. They found that CE-MRA results showed stenosis in a wider range of carotid and vertebral arteries in post-radiotherapy patients compared to those who had not received radiation. The incidence of significant common carotid artery (CCA) or internal carotid artery (ICA) stenosis was higher in older patients and in those with a longer interval since radiotherapy. In their study, 93.1% of patients had CCA/ICA stenosis, with 27% having significant stenosis [6].

Wang, Liao *et al*., in their meta-analysis, also found similar results regarding the increased prevalence of CAS in patients with nasopharyngeal carcinoma post-radiotherapy [7]. Fernández-Alvarez *et al*., in a review study, reported the incidence of CAS to range from 18% to 38% in head and neck cancer patients treated with radiation, compared to up to 9.2% among non-irradiated patients [13].

The proposed pathophysiology for radiation-induced carotid stenosis includes:
Endothelial dysfunction
Injury and occlusion of the vasa vasorum
Accelerated atherosclerosis

Radiation-induced CAS is characterized by arterial wall thickening and plaque formation, histologically similar to spontaneous atherosclerosis. It is believed that microvascular injury, particularly affecting the radiation-sensitive endothelial cells of the intima and vasa vasorum, plays a key role. Radiation can trigger inflammatory proliferation, migration, and differentiation of smooth muscle cells. This leads to collagen overproduction and extracellular matrix remodeling, resulting in arterial wall thickening and stiffening.

The initial process involves endothelial damage, nuclear disruption, platelet aggregation, and fibrin deposition, followed by destruction of the internal elastic lamina and marked endothelial thickening. These changes make the arteries stiffer and less elastic, potentially impairing diastolic function. Intimal proliferation of fibrous tissue and marked endothelial thickening ultimately cause luminal narrowing [8–11].

Avitia's criteria for diagnosing radiation-induced CAS include:
History of neck radiotherapy
No evidence of contralateral stenosis
A longer-than-usual stenotic segment

Our patient met two of these three criteria. These were proposed by Avitia in her study of radiation-induced CAS [12].

Several imaging modalities are available for diagnosing CAS. Duplex carotid ultrasonography is a feasible option even in resource-limited settings. Other modalities include CT angiography, MR angiography (MRA), and digital subtraction angiography (DSA). In our case, after MRA findings suggested stenosis, we proceeded with DSA to better understand the exact nature and severity of the stenosis, as well as to evaluate technical considerations in choosing between carotid endarterectomy (CEA) and carotid artery stenting (CAS).

There may be questions regarding whether the stenosis can be fully attributed to radiation. However, considering the patient's history, well-controlled blood pressure, absence of significant risk factors other than age, and the nature of the stenosis—longer segment involvement and a distribution pattern atypical of classic atherosclerosis—it is reasonable to conclude that radiation played a significant role.

Trojanowski P *et al*., noted that radiation-induced vascular lesions differ radiologically from atherosclerotic lesions. Post-radiation lesions typically involve longer arterial segments and are often multifocal, whereas atherosclerotic lesions tend to be unifocal, located at the carotid bifurcation and proximal ICA. Similar observations were made by Thalhammer C, Shichita T, and Kim BJ in their respective studies [14–17].

Treatment options for CAS include:

1. Percutaneous angioplasty with or without stenting
2. Carotid artery stenting (CAS)
3. Carotid endarterectomy (CEA)
4. Bypass surgery

CEA is traditionally considered the gold standard for CAS. However, radiation-induced changes make surgical management more challenging. Post-radiation vascular disease often involves multiple vessels and locations, leading to increased risks during surgery. Dissections in previously operated and irradiated necks, fibrosis, altered anatomy, and diffuse plaques complicate the surgical field and increase the risk of cranial nerve injury. Tallarita *et al*., found that open surgery in patients with prior radical neck dissection was associated with three times the complication rate [18–21].

Therefore, carotid artery stenting becomes a more favorable option in these patients. Sharing experiences, outcomes, and success rates with CAS in post-radiation cases is essential to inform and improve future management.

Although restenosis remains a concern, cutting balloon angioplasty has proven effective for in-stent restenosis. The use of cerebral protection devices reduces the risk of stroke from embolization. Advances in stent design, delivery systems, and protection devices are making CAS safer and more durable.

In addition to intervention, medical management plays a critical role. Dual antiplatelet therapy, statins, and routine surveillance with Doppler ultrasonography for early detection of significant stenosis are vital. Early detection and timely intervention can help prevent major strokes and reduce long-term disability.

CONCLUSION

Carotid artery stenosis greater than 50% is seen in approximately 25% of patients, with a cumulative risk exceeding 25% at 10 years post-radiation therapy [22]. However, the prevalence of radiation-induced carotid stenosis varies according to the primary cancer site. Significant independent predictors reported include nasopharyngeal and laryngeal cancers. There is a notable lack of large studies examining radiation-induced carotid stenosis following treatment for carcinomas of the tongue and the floor of the mouth.

A study by Seto K *et al*., Reported the incidence of radiation-induced carotid stenosis as only 4% in patients with tongue cancer [23]. This highlights the gap in data regarding prevalence, which hinders our ability to predict its development, detect it in its early stages, and implement preventive measures to avoid serious neurological sequelae.

Treatment for these patients is also challenging, as surgical intervention carries a higher risk due to multilevel inflammatory and fibrotic changes in the arterial wall, along with scarring of the neck tissues.

Our case emphasizes the importance of close follow-up in post-radiotherapy patients and suggests that carotid Doppler studies may play a crucial role in the early detection of carotid artery stenosis in this population.

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Conflict of Interest: There are no conflicts of interest

Informed Consent:

We certify that we have obtained all appropriate patient consent forms. In the form, the patient has given consent for his images and other clinical information to be reported in the journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

AUTHOR CONTRIBUTIONS

Dr Sakshi Puri: Concept, design, definition if intellectual content, manuscript preparation and editing

Dr Insha Aleena: Design, Data acquisition, manuscript preparation and editing, literature search

Dr Manoj Mahata: Concept, Manuscript editing, Literature review, Data acquisition

Dr Debabrata Chakraborty: Manuscript editing and review, literature review

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