

CASE REPORT

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Cerebral angiography in anterior circulation ischemic stroke with bilateral subclavian artery occlusion in subclavian steal syndrome: A case report and literature review

Muhammad Yunus Amran, Dwi Atmaji Norwanto

ABSTRACT

Introduction: Subclavian steal syndrome (SSS) is a hemodynamic phenomenon that occurs when a total occlusion in the subclavian artery (SA) proximal to the vertebral artery (VA) causes retrograde flow in the ipsilateral VA. Subclavian steal syndrome with total occlusion of bilateral SA is a very rare case.

Case Report: A 60-year-old woman reported experiencing sudden weakness on the right side of her body for eight days. Previously, the patient often felt shaky and cramped in his right and left hands. After a head computed tomography (CT) without contrast was performed, an infarct was found in the left centrum semiovale, left corona radiata, left posterior and anterior cornu periventricular, and right side of the pons. After cerebral digital subtraction angiography (C-DSA) was carried out, total occlusion of the bilateral SA was found, stenosis of the left M1 segment of the middle cerebral artery (MCA) branch.

Conclusion: Bilateral total occlusion of the SA is a very rare case and has rarely been reported before. In several studies, cases of unilateral SA occlusion resulted in SSS which provides an illustration of the reverse mechanism of blood vessel flow from the contralateral side of the occlusion. This backflow usually occurs in the contralateral vertebral artery. However, in this case, bilateral SA occlusion occurred so that there was no backflow mechanism in the VA. As compensation for the vascularization of the posterior circulation, collateral formation occurs from the external carotid artery (ECA) to the VA. However, this process causes a supply of blood flow to the anterior circulation, resulting in an anterior ischemic stroke.

Keywords: Anterior ischemic stroke, Cerebral digital subtraction angiography (C-DSA), Subclavian steal syndrome (SSS), Total subclavian artery occlusion

How to cite this article

Amran MY, Norwanto DA. Cerebral angiography in anterior circulation ischemic stroke with bilateral subclavian artery occlusion in subclavian steal syndrome: A case report and literature review. Int J Case Rep Images 2024;15(2):76–80.

Article ID: 101475Z01MA2024

doi: 10.5348/101475Z01MA2024CR

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Received: 27 June 2024

Accepted: 11 September 2024

Published: 21 October 2024

INTRODUCTION

Subclavian steal syndrome (SSS) is a hemodynamic phenomenon that occurs when a total occlusion in the subclavian artery (SA) proximal to the vertebral artery (VA) causes retrograde flow in the ipsilateral VA, leading to a redistribution of blood flow and resulting in various neurological and vascular symptoms. Subclavian

steal syndrome caused by complete occlusion of both subclavian arteries is exceptionally rare [1]. It is often first suspected during routine clinical examinations, particularly when the clinician observes a marked difference in blood pressure between the two upper extremities, typically greater than 20 mmHg. Additional clinical signs, such as a diminished or absent radial pulse on the affected side, or the presence of a supraclavicular bruit—an abnormal sound heard over the subclavian artery—may also raise suspicion. These findings usually prompt the clinician to pursue further diagnostic evaluations, such as Doppler ultrasound or advanced imaging techniques, to confirm the diagnosis and assess the severity of the arterial occlusion. Revascularization is typically considered for SSS when the condition, though often benign, presents with persistent or worsening symptoms such as dizziness, syncope, or limb ischemia. Additionally, revascularization may be warranted in cases where there are significant neurological symptoms, severe blood pressure discrepancies between the arms, or when the syndrome leads to complications that impair daily activities or pose a risk of more serious vascular events [2]. Confirmatory angiography is necessary in symptomatic situations, particularly those needing interventional therapy computed tomography angiography (CTA), magnetic resonance angiography (MRA), and cerebral digital subtraction angiography (C-DSA). Subclavian steal syndrome is thought to be a harmless hemodynamic event that serves as a marker of atherosclerosis. However, revascularization procedures are occasionally required in symptomatic instances, particularly when refractory symptoms are present, such as repeated vertebrobasilar transient ischemic attack (TIA) or symptomatic arm ischemia. During more than two-year follow-up of a large sample of SSS patients, only a few stroke problems were recorded (in 26% of cases); however, the majority of instances involved anterior circulation. The existence of overt symptoms in SSS patients is the only major risk factor for stroke [2]. Epidemiological data on the prevalence of SSS are limited. However, studies suggest that SSS affects approximately 0.6–6.4% of the general population. The condition is more frequently observed in older men, likely due to the higher prevalence of atherosclerosis in this demographic [3]. Overall, 2.2% of acute stroke patients were diagnosed with SSS, with men being the majority (68.1%) [2]. Here, we discuss a very rare case of anterior circulation ischemic stroke with bilateral total occlusion of subclavian artery in subclavian steal syndrome based on neuroimaging of C-DSA.

CASE REPORT

A 60-year-old woman was brought to the emergency room at Dr. Wahidin Sudirohusodo Hospital after experiencing sudden weakness on the right side of her body eight days prior. There was slurred speech, no preceding headache, no vomiting, blood pressure was not taken at

the time of the occurrence, and there was no decreased consciousness. Patients frequently experience swaying and cramping in both their right and left hands. There is a history of hypertension, although it is uncontrolled. Physical examination showed a blood pressure of 140/90 mmHg, pulse rate of 80 beats per minute, respiratory rate of 18 breaths per minute, and temperature of 36.7°C. Neurological testing confirmed consciousness on the Glasgow coma scale (GCS) E4M6V5. Isochor round pupil diameter 2.5 mm/2.5 mm, with direct light reflex +/+ and indirect light reflex +/+ in both eyes. Other cranial nerves were identified to have central type paresis, including right Nervus VII and Nervus XII, with strength of motoric 1 and motor movement in the right extremity reduced, tone of motoric was increased, physiological reflexes were normal, and the Babinski pathological reflex was positive. The right side of the body showed hemihypesthesia. A supporting electrocardiogram (ECG) test indicated left ventricular hypertrophy. Laboratory leukocytes 4,900/uL, hemoglobin 13.0 g/dL, platelets 163,000/uL, total cholesterol 178, high-density lipoprotein (HDL) 47, and LDL 113. The chest X-ray revealed cardiomegaly. A CT scan of the head without contrast revealed infarctions in the left centrum semiovale, left corona radiata, left posterior and anterior horn periventricular regions, and right pons (Figure 1). Cerebral digital subtraction angiography (C-DSA) revealed stenosis of the left M1 segment of the middle cerebral artery (MCA) (Figure 2) and total occlusion of the subclavian arteries (Figure 3).

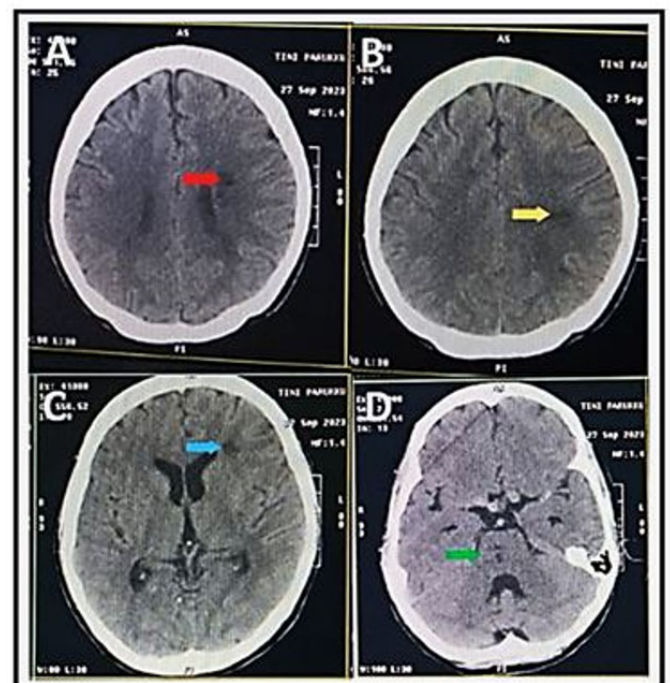


Figure 1: CT scan of the head without contrast. (A) Red arrow: Left centrum semiovale infarction; (B) Yellow arrow: Left corona radiata infarction; (C) Blue arrows: Left anterior horn periventricular infarction; (D) Green arrow: Right-sided pontine infarction.

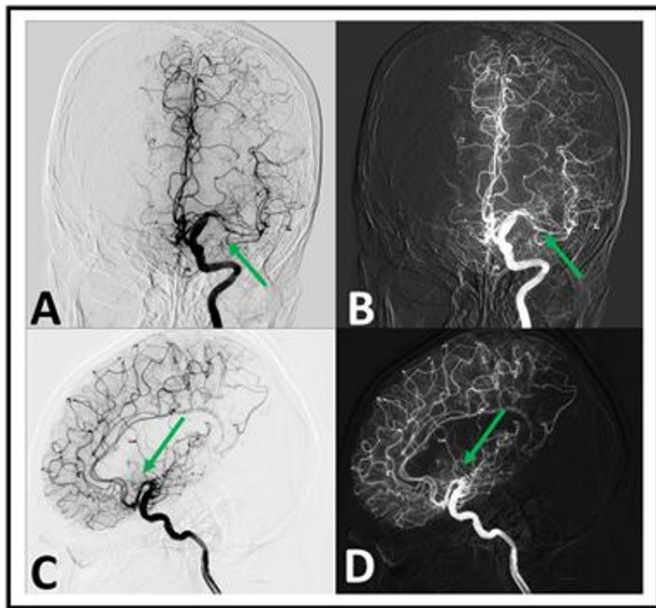


Figure 2: Cerebral digital subtraction angiography (C-DSA) in a patient with left M1 segment middle cerebral artery (MCA) branch stenosis. (A) Injection contrast from Lt-ICA AP view; (B) Injection contrast from Lt-ICA AP view roadmap; (C) Injection contrast from Lt-ICA lateral view; and (D) Injection contrast from Lt-ICA lateral view roadmap.

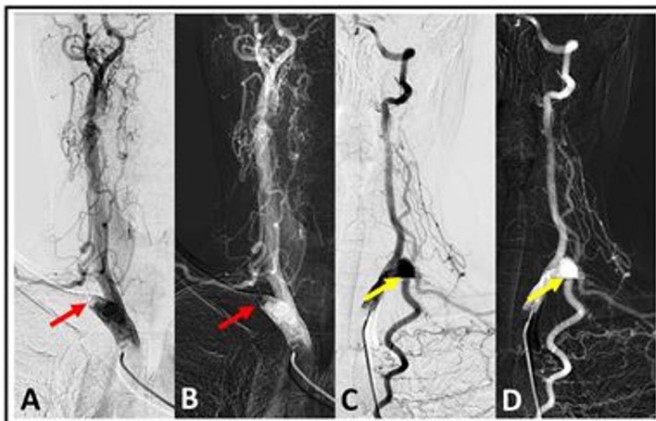


Figure 3: Cerebral digital subtraction angiography (C-DSA) in a patient with bilateral total occlusion of subclavian artery. (A) Injection of contrast from brachiocephalic trunk, showing a total occlusion of right (Rt) subclavian artery (SA) at the proximal of Rt-vertebral artery (VA) ostium; (B) Injection of contrast from brachiocephalic trunk, showing a total occlusion of Rt-SA at the proximal of Rt-VA ostium roadmap; (C) Injection of contrast from left (Lt) SA, showing a total occlusion just distal of Lt-VA ostium; and (D) Injection of contrast from Lt-SA, showing a total occlusion just distal of Lt-VA ostium roadmap.

DISCUSSION

Subclavian steal syndrome is a hemodynamic phenomenon that occurs when a total occlusion in the subclavian artery (SA) proximal to the vertebral artery (VA), causing retrograde flow in the ipsilateral VA [4]. This condition can result in a significant drop in subclavian artery pressure in the distal region of the

lesion. If stenosis is severe and the affected arm is used, the decreased pressure may lead to retrograde blood flow [1]. Atherosclerotic vascular disease is the most common cause of subclavian steal syndrome. Tobacco use, hyperlipidemia, hypertension, diabetes mellitus, family history, and age are all risk factors for atherosclerosis. Other reasons, however relatively rare, include aortic dissection, Takayasu's arteritis, external pressure on the subclavian artery, and anatomical abnormalities including an isolated innominate artery [1]. The patient in this case had notable risk factors including hypertension and hyperlipidemia.

The left and right subclavian arteries primarily supply the posterior region of the encephalon, spinal cord, and upper extremities. The right subclavian artery arises from the brachiocephalic arterial trunk, whereas the left subclavian artery originates from the aortic arch. Each subclavian artery ends below the center of the clavicle and becomes the axillary artery [5]. The right subclavian artery originates behind the sternoclavicular joint and travels laterally, forming a curve with a dip at the pleural dome and first rib. The left subclavian artery begins in the aortic arch and climbs vertically before following the same arch course as the one next to it. The interscalic gap contains the two subclavian arteries, which travel between the anterior and middle scalene muscles. The subclavian artery has numerous branches. The VA, internal mammary artery (IMA), thyrocervical trunk, costo-cervical trunk, and dorsal scapular artery [5].

The VA supplies blood to the posterior region of the brain and the cranial section of the spinal cord. This artery emerges from the top surface of the subclavian artery and travels vertically to the C6 vertebra. It enters C6's transverse foramina and travels from bottom to top via all of the transverse foramina of the vertebrae above it. It emerges from the atlas' transverse foramen and forms the curve that surrounds the posterior side of the lateral face. Finally, it crosses the posterior atlanto-occipital membrane and enters the foramen magnum, merging with the basilar artery [5].

The basilar artery is produced by two VA and connects to the brain's anterior circulation, which is made up of the Willis circle. However, steno-occlusive lesions of the proximal superior cerebellar artery (SCA) might result in reduced blood flow to the upper extremity. Blood travels sequentially from the contralateral VA to the basilar artery, around the Willis circle, and down through the VA to feed the afflicted upper extremity, resulting in upper extremity and vertebrobasilar insufficiency. This altered physiology is reflected in the signs and symptoms that characterize SSS. Studies show that 82.3% of lesions are predominantly on the left side, attributed to a steeper curve at the origin of the left superior cerebellar artery, which increases blood flow turbulence and promotes atherosclerotic plaque formation. The majority of patients are asymptomatic due to the development of collateral circulation [3].

Significant stenosis of the SA reduces circulation distal to the IMA, VA, or axillary artery. As the severity of subclavian stenosis increases, the pressure distal to the stenosis will eventually fall below the pressure communicated by the contralateral (unimpaired) VA via the basilar artery or the carotid artery via the circle of Willis and basilar artery. As a result, the pressure gradient promotes reverse blood flow (retrograde flow) in the vertebral artery distal and ipsilateral to the subclavian stenosis [6]. In this case, the patient frequently has cramps in both hands and has a discrepancy in blood pressure in the upper and lower limbs.

The flow of cerebral blood arteries is divided into two circulatory systems: anterior (carotid) and posterior (vertebrobasilar). The carotid (anterior) system consists of two pairs of internal carotid arteries, whereas the vertebrobasilar system consists of one basilar artery and two VA. The anterior and posterior communicating arteries will join these two circulatory systems, forming a network of collateral blood vessels that will run across the Willis circle [7]. When an obstruction arises, the collateral system helps to direct blood flow to the brain. This circulation is divided into two categories: main collateral circulation (arterial segments of the Willis circle) and secondary collateral circulation (ophthalmic artery and leptomeningeal arteries). With this collateral system, obstructions in intracranial blood flow may not always result in evident stroke symptoms. Stroke symptoms will develop if the current collateral system is not functioning properly or if the blocked blood vessel is an end artery.

The treatment given is the administration of double antiplatelets, a statin (Atorvastatin) works to reduce low-density lipoprotein (LDL) cholesterol levels and triglycerides and increases high-density lipoprotein (HDL) levels, a neuroprotector (Citicoline) which increases the main components of cell membranes by synthesizing phosphatidylcholine and prevents cell membrane damage [8]. Citicoline can also inhibit the release of free fatty acids and glutamate, thereby preventing neuronal apoptosis and inflammation. Citicoline was shown to have long-term benefit in ischemic stroke as assessed using the NIHSS at day 90 post-intervention [9].

CONCLUSION

Subclavian steal syndrome can result from complete blockage of the subclavian artery, either unilaterally or bilaterally. Cases that occur bilaterally are extremely rare. Because of the existence of the collateral system, symptoms and signs might vary widely. The most prevalent physical examination findings include a significant differential in blood pressure between the upper extremities (>20 mmHg), a decreased or absent radial pulse, and a supraclavicular bruit. Computed tomography angiography (CTA), magnetic resonance angiography (MRA), and cerebral digital subtraction angiography (C-DSA) are

all possible support investigations. Management may administer both antiplatelet and statin medications.

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Author Contributions

Muhammad Yunus Amran – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Dwi Atmaji Norwanto – Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Guarantor of Submission

The corresponding author is the guarantor of submission.

Source of Support

None.

Consent Statement

Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.

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Article citation: Amran MY, Norwanto DA. Cerebral angiography in anterior circulation ischemic stroke with bilateral subclavian artery occlusion in subclavian steal syndrome: A case report and literature review. Int J Case Rep Images 2024;15(2):76–80.



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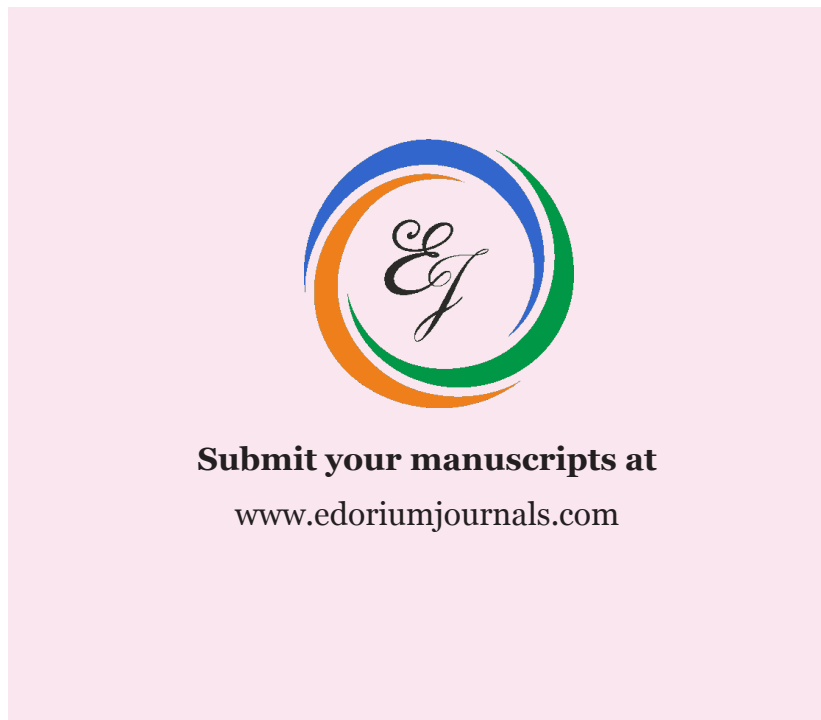
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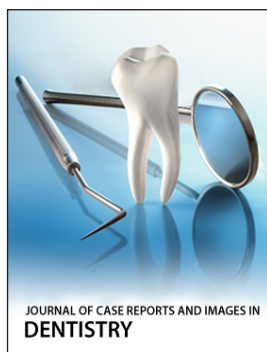
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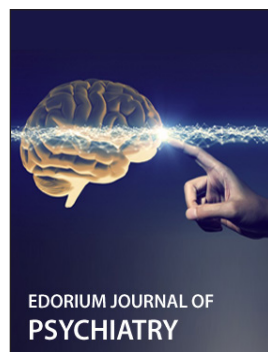
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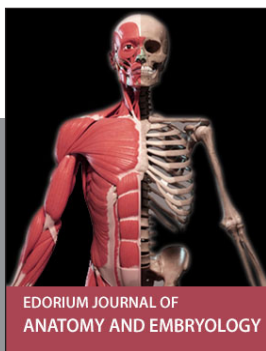
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