Complete Right Internal Carotid Artery Occlusion in Ischemic Stroke: DSA Case Report

Ari Bandana Tasrif [1] ✉, Nasrul Musadir [2], Nona Suci Rahayu [3]
[1, 2, 3)] Universitas Syiah Kuala

✉ Corresponding author:
ari_tasrif@usk.ac.id

Abstrak

Latar Belakang: Digital subtraction angiography (DSA) merupakan modalitas pencitraan vaskular yang membantu mengidentifikasi lokasi dan karakteristik oklusi arteri pada stroke iskemik. Presentasi Kasus: Seorang laki-laki berusia 60 tahun dengan riwayat hipertensi dan diabetes melitus yang tidak terkontrol dirujuk dengan keluhan kelemahan anggota gerak kiri dan disartria yang berlangsung selama kurang lebih dua hari. Pemeriksaan neurologis menunjukkan paresis nervus fasialis dan hipoglosus kiri, kelemahan motorik berat pada sisi kiri tubuh, serta skor National Institutes of Health Stroke Scale (NIHSS) sebesar 23. Pemeriksaan computed tomography (CT) kepala tanpa kontras menunjukkan infark serebri, sedangkan pemeriksaan DSA mengidentifikasi oklusi total arteri karotis interna (internal carotid artery/ICA) kanan pada bifurkasi karotis.Kesimpulan: DSA memberikan informasi anatomis mengenai oklusi arteri yang melengkapi temuan infark pada pemeriksaan CT. Integrasi penilaian klinis dan temuan pencitraan sangat penting untuk memahami kelainan vaskular yang mendasari stroke iskemik serta mendukung perencanaan terapi yang tepat.

Kata kunci: *Digital subtraction angiography*; Stroke iskemik; Oklusi arteri karotis interna.

Abstract

Background: Digital subtraction angiography (DSA) is a vascular imaging modality that helps identify the location and characteristics of arterial occlusion in ischemic stroke. Case Presentation: A 60-year-old man with a history of uncontrolled hypertension and diabetes mellitus was referred with left-sided limb weakness and dysarthria lasting approximately two days. Neurological examination revealed left facial and hypoglossal nerve palsies, severe left-sided motor weakness, and a National Institutes of Health Stroke Scale (NIHSS) score of 23. Non-contrast computed tomography (CT) of the head demonstrated cerebral infarction, while DSA identified complete occlusion of the right internal carotid artery (ICA) at the carotid bifurcation. Conclusion: DSA provides anatomical information regarding arterial occlusion that complements the infarction findings on CT. Integrating clinical assessment and imaging findings is essential for understanding the vascular abnormalities underlying ischemic stroke and supporting appropriate treatment planning.

Keywords: *Digital subtraction angiography; Ischemic stroke; ICA occlusion*.

INTRODUCTION

Ischemic stroke remains a major global health problem because it can cause death or long-term disability that affects patients' lives.[1] It occurs when blood supply to brain tissue is disrupted by vascular occlusion, depriving brain cells of the oxygen and nutrients required to maintain their function.[2] Clinical manifestations vary among patients depending on the affected vessel, the extent of ischemic tissue, and the timeliness of treatment. In some cases, particularly when a large intracranial artery is occluded, impaired blood flow can lead to extensive brain tissue damage and significant neurological deficits.[3] These considerations indicate that the evaluation of ischemic stroke should not focus solely on clinical manifestations and infarct

imaging but should also consider the underlying vascular condition. Identifying the location and characteristics of arterial occlusion is important for understanding the mechanisms of cerebral infarction, estimating the extent of vascular impairment, and selecting an appropriate management strategy.[4]

Advances in imaging technology have transformed the diagnostic approach to ischemic stroke from one focused primarily on brain tissue to one that also directly evaluates the cerebral vasculature.[5] Computed tomography angiography (CTA) and magnetic resonance angiography (MRA) are widely used to rapidly identify intracranial arterial occlusion and help select patients for reperfusion therapy.[4] Nevertheless, in selected cases, more detailed assessment of vessel patency, occlusion location, arterial filling patterns, and collateral circulation may be needed. Such information can help clinicians understand the vascular abnormalities underlying cerebral infarction and consider subsequent diagnostic or therapeutic steps.[6]

Digital subtraction angiography (DSA) is an invasive angiographic modality that provides dynamic visualization of blood vessels by depicting contrast flow from the arterial through the venous phase. In neurovascular practice, DSA plays an important role in assessing vessel patency, determining the location and extent of occlusion, evaluating collateral circulation, and identifying other vascular abnormalities that may contribute to ischemic events.[5] With the development of endovascular treatment for acute ischemic stroke, DSA has also become an integral component of diagnostic angiography and interventional procedures, including mechanical thrombectomy in selected patients. However, because DSA is invasive and carries procedure-related risks, its use should be guided by the clinical indication and the expected additional information compared with noninvasive imaging modalities.[4]

Despite advances in neuroimaging and reperfusion therapies, the interpretation of intracranial angiographic findings remains closely linked to the patient's clinical presentation and brain imaging results. The identification of an arterial occlusion on digital subtraction angiography (DSA) should therefore extend beyond its anatomical location to include its relationship with the distribution of cerebral infarction and the possible underlying stroke mechanism. In addition, an assessment of collateral circulation may provide valuable information about the hemodynamic status of the affected brain territory, although angiographic collateral findings should be interpreted alongside other imaging and clinical parameters.[4,5] This integrated approach allows DSA findings to be understood within the broader pathophysiological context of ischemic stroke rather than as isolated anatomical observations.[7]

In light of these considerations, this case report aims to describe the digital subtraction angiography (DSA) findings in a patient with cerebral infarction associated with intracranial arterial occlusion. The case highlights the role of DSA in delineating the location and characteristics of vascular occlusion, while emphasizing the importance of interpreting these findings in conjunction with the patient's clinical presentation and other neuroimaging results.[7] By presenting the angiographic findings alongside the broader clinical context, this report seeks to contribute to a more comprehensive understanding of intracranial vascular assessment in patients with cerebral infarction.[4]

CASE PRESENTATION

A 60-year-old man was referred from a regional hospital with left-sided limb weakness that had begun approximately two days before admission and progressively worsened. Initially, he was still able to eat, drink, and speak coherently; however, he subsequently developed slurred speech and limb weakness. He had no preceding headache, seizures, or vomiting. His medical history included uncontrolled diabetes mellitus and hypertension.

On examination in the emergency department, the patient was alert, with a blood pressure of 168/97 mmHg and a pulse rate of 85 beats/minute. His respiratory rate and body temperature were within normal limits. His Glasgow Coma Scale score was E4V5M6, and

dysarthria was noted. Neurological examination revealed equal pupils, left cranial nerve VII and XII palsies, and left-sided motor strength of 1/5. The NIHSS score was 23.

Non-contrast head computed tomography (CT) (Figure 1) demonstrated cerebral infarction. The patient subsequently underwent DSA, which revealed complete occlusion of the right internal carotid artery (ICA) at the carotid bifurcation (Figure 2). Acute stroke management was then initiated.

RESULTS AND DISCUSSION

This case describes ischemic stroke with severe neurological deficits in a 60-year-old man with a history of uncontrolled hypertension and diabetes mellitus. Both conditions are important vascular risk factors that can accelerate vascular damage through several mechanisms, including endothelial dysfunction and the development of atherosclerosis.[8] These changes can impair vascular integrity and function and increase the risk of cerebrovascular events, including ischemic stroke. Therefore, controlling blood pressure and blood glucose, together with evaluating other vascular risk factors, is an essential component of patient management.[9] These measures aim not only to reduce the risk of subsequent vascular events but also to prevent recurrent stroke.[10] In this patient, left-sided limb weakness accompanied by dysarthria and left cranial nerve VII and XII palsies suggests neurological dysfunction that may be associated with involvement of the motor pathways in the right hemisphere. Anatomically, these findings are consistent with a suspected right supratentorial lesion affecting the corticobulbar and corticospinal pathways.[11]

The patient's National Institutes of Health Stroke Scale (NIHSS) score of 23 indicates severe neurological deficits. In acute ischemic stroke, this degree of severity should raise concern for possible large-vessel occlusion (LVO), particularly when accompanied by profound limb weakness.[12] However, the NIHSS measures the severity of neurological deficits and cannot independently confirm the presence or location of an arterial occlusion. Identifying the occlusion site and assessing damaged brain tissue as well as potentially salvageable tissue require appropriate imaging. Clinical findings should therefore be correlated with head CT and vascular imaging, such as CT angiography (CTA) or digital subtraction angiography (DSA), according to the clinical indication.[13]

The approximately two-day duration of symptoms before hospital presentation is an important consideration in determining the management approach for ischemic stroke. The time from symptom onset should be distinguished from the last known well (LKW), defined as the last time the patient was known to be at their neurological baseline, because eligibility for reperfusion therapy depends on time, clinical status, and imaging findings. The DAWN trial demonstrated that mechanical thrombectomy may benefit selected patients with anterior-circulation LVO 6–24 hours after LKW when clinical-core mismatch criteria are met. The DEFUSE 3 trial demonstrated benefit in selected patients 6–16 hours after LKW based on perfusion imaging criteria indicating potentially salvageable brain tissue.[14,15] However, these findings cannot be generalized to all patients presenting late. In this case, the symptom duration of approximately two days was beyond the time windows studied in both trials; therefore, a benefit from thrombectomy cannot be assumed on the basis of those studies. Nevertheless, DSA can provide important information about the location and characteristics of arterial occlusion, which should be interpreted alongside brain parenchymal imaging and the patient's clinical condition to better understand the vascular abnormalities underlying the stroke.[4]

Non-contrast head CT is an important initial investigation in patients with suspected acute stroke. It is primarily used to distinguish ischemic stroke from intracranial hemorrhage and to identify parenchymal changes suggestive of infarction. In this case, CT demonstrated cerebral infarction, supporting the diagnosis of ischemic stroke.[16] However, non-contrast CT does not always directly show the location of arterial occlusion. It is also limited in its ability to characterize the vascular lumen, occlusion length, and filling patterns of distal vessels.

Therefore, the infarction identified on CT alone cannot fully define the vascular abnormality underlying this patient's stroke.[17]

Vascular imaging modalities, including CT angiography (CTA), MR angiography (MRA), and DSA, provide additional information about vessel patency. CTA and MRA are generally used for noninvasive assessment, whereas DSA provides high-resolution angiographic images and dynamic information about luminal filling and contrast flow. The choice of modality should be tailored to the patient's condition, the diagnostic objective, the availability of facilities, and whether the findings are likely to influence treatment decisions. In this case, CT and DSA served complementary roles. CT identified parenchymal damage caused by infarction, whereas DSA demonstrated the vascular abnormality that may explain the vascular mechanism underlying the patient's clinical manifestations. Integrating these two examinations is central to evaluating ischemic stroke when large-artery occlusion is suspected.[4,18]

The main finding in this case was complete occlusion of the right ICA at the carotid bifurcation, identified by DSA. This finding provides more specific anatomical information than the general diagnosis of cerebral infarction. Clinically, identifying the occlusion site is important because the internal carotid artery is a major source of blood supply to much of the anterior cerebral circulation through the anterior and middle cerebral arteries. Impaired flow through this artery can cause cerebral ischemia, depending on the lesion location, the condition of distal vessels, and the effectiveness of collateral circulation.[19]

Digital subtraction angiography (DSA) is an angiographic examination in which contrast medium is injected directly into an artery and a series of X-ray images is acquired to depict the vessels and contrast flow. Digital subtraction compares images acquired before and after contrast administration to reduce visualization of bone and surrounding tissue, allowing the vascular lumen to be seen more clearly.20 In patients with ischemic stroke, DSA can help identify the location and characteristics of arterial occlusion. When imaging coverage and acquisition phases are adequate, it can also provide information about distal vessel filling, contrast-flow patterns, and collateral circulation. These findings complement brain parenchymal imaging and may help explain the vascular abnormalities underlying the patient's clinical presentation.[21]

The diagnostic benefits of DSA must be weighed against its procedural risks. Although it provides detailed vascular images and plays an important role in neurointerventional procedures, its invasive nature carries risks such as cerebral embolism, hematoma or bleeding at the arterial access site, contrast reactions, and vascular injury. Accordingly, CTA is often used as the initial vascular imaging examination in acute ischemic stroke to identify LVO because it can be performed rapidly without intra-arterial catheterization.[22] DSA is generally considered when more detailed evaluation of vascular anatomy and flow is required or when an endovascular procedure, such as mechanical thrombectomy, is planned. The imaging modality should be selected according to the patient's clinical condition, diagnostic needs, and available facilities so that the expected benefit outweighs the potential risks.[23]

ICA occlusion can cause cerebral infarction through two main mechanisms: hemodynamic impairment due to reduced distal perfusion and thromboembolism associated with atherosclerosis or thrombus formation. In hemodynamic impairment, reduced perfusion pressure can cause ischemia if collateral circulation cannot maintain adequate blood flow. In the thromboembolic mechanism, thrombotic material may obstruct distal vessels and cause infarction in the corresponding vascular territory.[24]

Collateral circulation plays an important role in determining the effects of ICA occlusion on brain tissue. Some patients with large-artery occlusion maintain perfusion through collateral pathways, whereas others experience more extensive reductions in perfusion. Therefore, the occlusion site alone is insufficient to predict infarct extent, deficit severity, or clinical outcome. DSA-based collateral assessment may provide additional information about alternative blood-flow pathways, but conclusions must be based on the actual angiographic images.[25]

Identifying complete right ICA occlusion by DSA has implications for management because it clarifies the location of the vascular lesion and provides anatomical information relevant to considering endovascular intervention. Clinical trials such as MR CLEAN, ESCAPE, EXTEND-IA, and SWIFT PRIME have demonstrated the benefits of mechanical thrombectomy in selected patients with ischemic stroke due to LVO. However, these benefits must be interpreted in light of patient-selection criteria, occlusion location, treatment timing, and the characteristics of the ischemic brain tissue.[26]

In this case, the patient was referred after approximately two days of stroke symptoms and had an NIHSS score of 23, indicating severe neurological deficits. This underscores the importance of comprehensively assessing the last known well, infarct location and extent, the presence of intracranial occlusion, and the possibility of salvageable brain tissue. Although DSA identified ICA occlusion, this finding alone does not establish an indication for mechanical thrombectomy. The DAWN and DEFUSE 3 trials demonstrated benefits of thrombectomy in selected patients within treatment windows extending up to 24 hours from LKW, subject to specific clinical and imaging criteria. Because this patient's symptoms had persisted for approximately 48 hours, the presentation was beyond the time windows studied in those trials. Thus, thrombectomy cannot be recommended on the basis of those trials alone; clinical decisions should consider the patient's overall condition and applicable guidelines.[4,14,15]

Patient management should include organized stroke care, neurological monitoring, prevention of complications, and control of vascular risk factors. The patient's uncontrolled hypertension and diabetes mellitus require targeted assessment and treatment. After the acute phase, secondary prevention should be tailored to the established stroke etiology and may include antiplatelet or anticoagulant therapy when indicated, lipid management, blood pressure and glycemic control, and rehabilitation.[10,27]

The principal value of DSA in this case was its ability to directly identify complete right ICA occlusion, providing vascular characterization that complemented the infarction findings on CT. The examination helped relate the clinical manifestations to a relevant arterial abnormality and provided an anatomical basis for further assessment of distal circulation and possible neurointerventional treatment. Thus, the contribution of DSA was not merely to confirm a vascular disorder but to define the location of a lesion important in the evaluation of ischemic stroke.[28]

Nevertheless, DSA is not the only modality for detecting LVO. In many acute stroke pathways, CTA can provide rapid vascular information without intra-arterial catheterization. DSA is better regarded as a method for detailed angiographic characterization and as an important component of endovascular procedures, rather than as a test that must be performed in every patient with stroke. The choice of examination should take into account whether the additional information is likely to affect clinical decisions.[17,28]

Figures

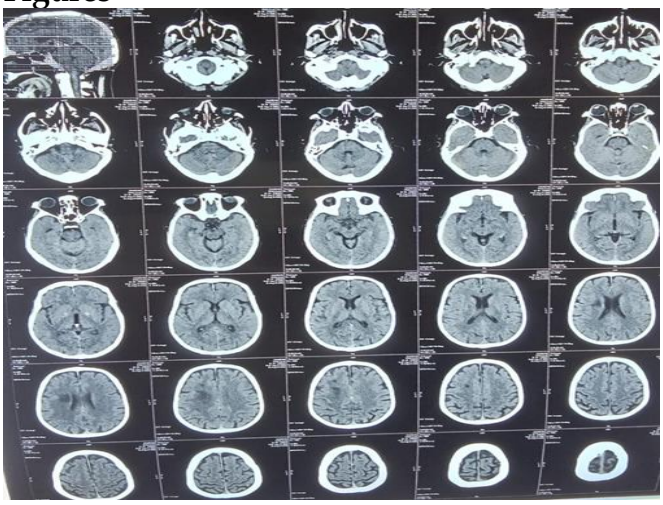


Figure 1. Head CT Scan

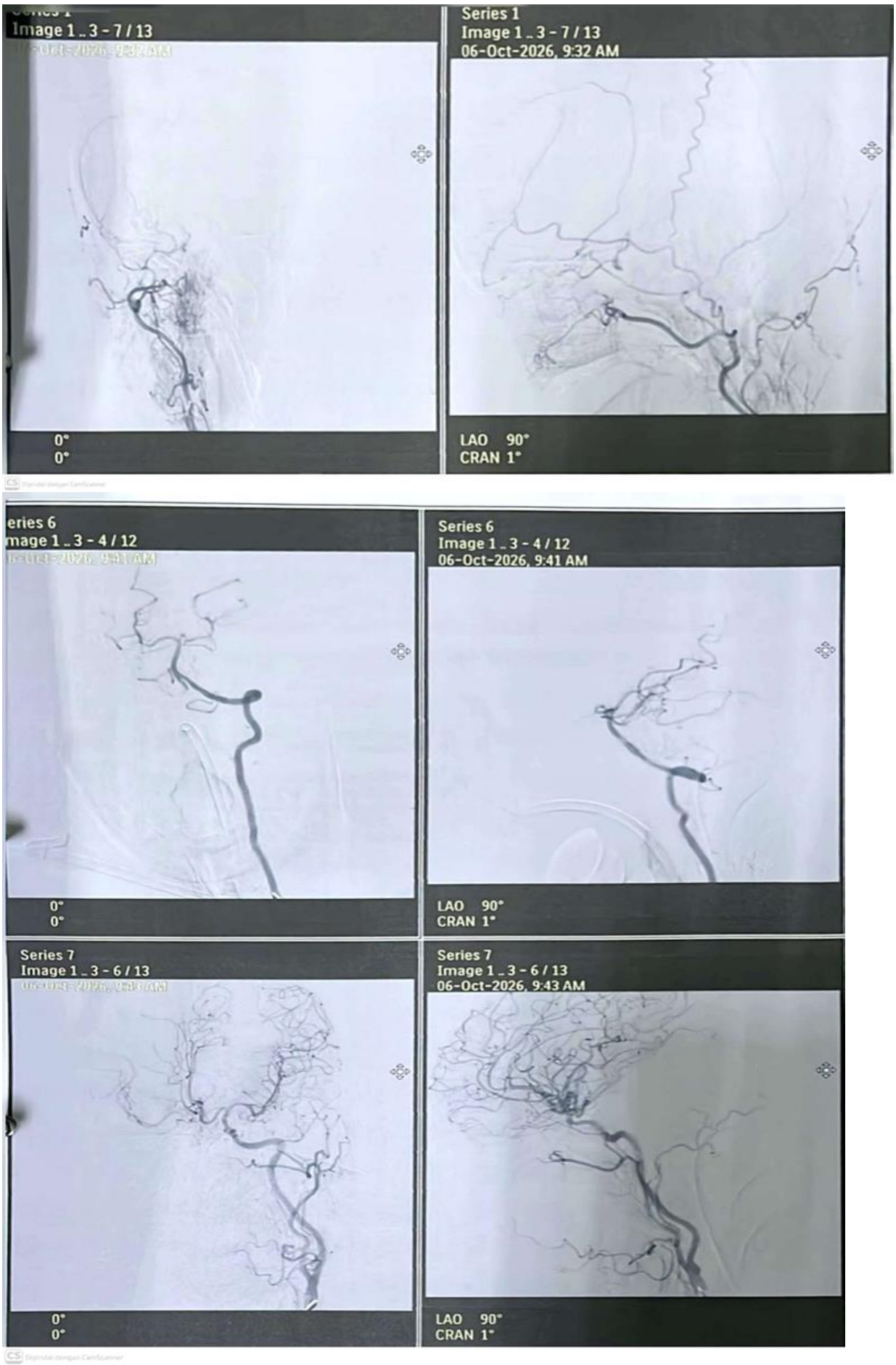

Image 1 .. 3 - 7 / 13
0°
0°
Series 1
Image 1 .. 3 - 7 / 13
06-Oct-2026, 9:32 AM
LAO 90°
CRAN 1°
eries 6
mage 1 .. 3 - 4 / 12
0°
0°
Series 6
Image 1 .. 3 - 4 / 12
06-Oct-2026, 9:41 AM
LAO 90°
CRAN 1°
Series 7
Image 1 .. 3 - 6 / 13
0°
0°
Series 7
Image 1 .. 3 - 6 / 13
06-Oct-2026, 9:43 AM
LAO 90°
CRAN 1°

Figure 2. DSA

CONCLUSION

This case demonstrates the important role of DSA in evaluating ischemic stroke when large-vessel occlusion is suspected. In a patient with severe neurological deficits, non-contrast head CT demonstrated cerebral infarction, whereas DSA identified complete occlusion of the right ICA at the carotid bifurcation. The two examinations provided complementary information about brain parenchymal injury and the underlying vascular abnormality.

These findings emphasize the importance of integrating clinical assessment, brain parenchymal imaging, and angiography to understand stroke mechanisms and plan appropriate management. However, treatment decisions and outcome prediction cannot be based solely on the occlusion site; they require consideration of symptom timing, infarct extent, distal vessel status, collateral circulation, and the patient's overall clinical condition.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to all parties who contributed to the completion of this article. Hopefully, this work will be beneficial for readers.

REFERENCES

1. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet Neurology. 2021;20(10):795–820. doi: 10.1016/S1474-4422(21)00252-0
2. Kuriakose D, Xiao Z. 2020. Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives. Int J Mol Sci. 2020 Oct 15;21(20):7609. doi: 10.3390/ijms21207609.
3. Goyal M, Menon BK, van Zwam WH, Dippel DWJ, Mitchell PJ, Demchuk AM, et al. 2016. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. The Lancet. 2016;387(10029):1723–1731. doi: 10.1016/S0140-6736(16)00163-X.
4. Prabhakaran S, Gonzalez NR, Zachrison KS, Adeoye O, Alexandrov AW, Ansari SA, Chapman S, Czap AL, Dumitrascu OM, Ishida K, Jadhav AP, Johnson B, Johnston KC, Khatri P, Kimberly WT, Lee VH, Leslie-Mazwi TM, Mac Grory B, Madsen TE, Menon B, Mistry EA, Park S, Parker S, Pérez de la Ossa N, Reeves M, Saiz T, Scott PA, Schwartzberg D, Sheth SA, Sporns PB, Times S, Tjoumakaris S, Wolfe SQ, Yaghi S. 2026. Correction to: 2026 Guideline for the Early Management of Patients With Acute Ischemic Stroke: A Guideline From the American Heart Association/American Stroke Association. Stroke. 2026 Aug;57(8):e461-e467. doi: 10.1161/STR.0000000000000530.
5. Shaban S, Huasen B, Haridas A, Killingsworth M, Worthington J, Jabbour P, et al. 2022. Digital subtraction angiography in cerebrovascular disease: current practice and perspectives on diagnosis, acute treatment and prognosis. Acta Neurologica Belgica. 2022;122(3):763–780. doi: 10.1007/s13760-021-01805-z.
6. Kauw F, Dankbaar JW, Martin BW, Ding VY, Boothroyd DB, Ommen FV, et al. 2020. Collateral Status in Ischemic Stroke: A Comparison of Computed Tomography Angiography, Computed Tomography Perfusion, and Digital Subtraction Angiography. J Comput Assist Tomogr 2020;44: 984–992. doi: 10.1097/RCT.0000000000001090.
7. Lee SJ, Liu B, Rane N, et al. 2021. Correlation between CT angiography and digital subtraction angiography in acute ischemic strokes. Clinical Neurology and Neurosurgery. 2021;200:106399. doi: 10.1016/j.clineuro.2020.106399.
8. Alkahtani R. 2022. Molecular mechanisms underlying some major common risk factors of stroke. Heliyon. 2022;8(8):e10218. doi: 10.1016/j.heliyon.2022.e10218.
9. Jia G, Sowers JR. 2021. Hypertension in diabetes: an update of basic mechanisms and clinical disease. Hypertension. 2021;78(5):1197–1205. doi: 10.1161/HYPERTENSIONAHA.121.17981.
10. Kleindorfer DO, Towfighi A, Chaturvedi S, Cockroft KM, Gutierrez J, Lombardi-Hill D, et al. 2021 Guideline for the prevention of stroke in patients with stroke and transient ischemic

attack: a guideline from the American Heart Association/American Stroke Association. Stroke. 2021;52(7):e364–e467. doi: 10.1161/STR.0000000000000375.
11. Lohia A, McKenzie J. Neuroanatomy, Pyramidal Tract. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: NCBI Bookshelf https://www.ncbi.nlm.nih.gov/books/NBK545314/https://www.ncbi.nlm.nih.gov/books/NBK545314/
12. Goyal M, Menon BK, van Zwam WH, et al. 2016. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. Lancet. 2016;387(10029):1723-1731. doi: 10.1016/S0140-6736(16)00163-X.
13. Fasen BACM, Heijboer RJJ, Hulsmans FJ, Kwee RM. 2021. Diagnostic performance of single-phase CT angiography in detecting large vessel occlusion in ischemic stroke: a systematic review. Eur J Radiol. 2021;134:109458. doi: 10.1016/j.ejrad.2020.109458
14. Nogueira RG, Jadhav AP, Haussen DC, Bonafe A, Budzik RF, Bhuva P, et al. 2018. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. N Engl J Med. 2018;378(1):11–21. doi: 10.1056/NEJMoa1706442.
15. Albers GW, Marks MP, Kemp S, Christensen S, Tsai JP, Ortega-Gutierrez S, et al. 2018. Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging. N Engl J Med. 2018;378(8):708–718. doi: 10.1056/NEJMoa1713973.
16. Campbell BCV, Mitchell PJ, Kleinig TJ, et al. 2015. Endovascular therapy for ischemic stroke with perfusion-imaging selection. N Engl J Med. 2015;372(11):1009-1018. doi: 10.1056/NEJMoa1414792.
17. Powers WJ, Rabinstein AA, Ackerson T, et al. 2019. Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines for the early management of acute ischemic stroke. Stroke. 2019;50(12):e344-e418. doi: 10.1161/STR.0000000000000211.
18. Wintermark M, Sanelli PC, Albers GW, Bello JA, Derdeyn CP, Hetts SW, et al. 2013. Imaging recommendations for acute stroke and transient ischemic attack patients: a joint statement by the American Society of Neuroradiology, the American College of Radiology, and the Society of NeuroInterventional Surgery. AJNR Am J Neuroradiol. 2013;34(11):E117–E127. doi: 10.3174/ajnr.A3690.
19. Lima AV, Lima MV, Marques MT, Gagliardi VD, Gagliardi RJ. 2026. Treatment of carotid stenosis: an updated review. Front Stroke. 2026 Jun 24;5:1849877. doi: 10.3389/fstro.2026.1849877.
20. Wen WL, Fang YB, Yang PF, Zhang YW, Wu YN, Shen H, et al. 2016. Parametric digital subtraction angiography imaging for the objective grading of collateral flow in acute middle cerebral artery occlusion. World Neurosurg. 2016;88:119–125. doi: 10.1016/j.wneu.2015.12.084.
21. Kauw F, Dankbaar JW, Martin BW, Ding VY, Boothroyd DB, van Ommen F, et al. 2020. Collateral status in ischemic stroke: a comparison of computed tomography angiography, computed tomography perfusion, and digital subtraction angiography. J Comput Assist Tomogr. 2020;44(6):984–992. doi: 10.1097/RCT.000000000000109.
22. Willinsky RA, Taylor SM, terBrugge K, Farb RI, Tomlinson G, Montanera W. 2003. Neurologic complications of cerebral angiography: prospective analysis of 2,899 procedures and review of the literature. Radiology. 2003;227(2):522–528. doi: 10.1148/radiol.2272012071.
23. Nam HY, Jang DK, Cho BR. 2022. Complications and risk factors after digital subtraction angiography: 1-year single-center study. J Cerebrovasc Endovasc Neurosurg. 2022;24(4):335-340. DOI: https://doi.org/10.7461/jcen.2022.E2022.05.001.
24. Mayer L, Grams A, Freyschlag CF, Gummerer M, Knoflach M, 2020. Management and prognosis of acute extracranial internal carotid artery occlusion. Ann Transl Med. 2020 Oct;8(19):1268. doi: 10.21037/atm-20-3169.

25. Venema SM, Dankbaar JW, Lugt AV, Dippel DW, Worp HB. 2022. Cerebral Collateral Circulation in the Era of Reperfusion Therapies for Acute Ischemic Stroke. Stroke. 2022 Oct;53(10):3222-3234. doi: 10.1161/STROKEAHA.121.037869.
26. Berkhemer OA, Fransen PS, Beumer D, Berg LA, et al. 2015. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med. 2015 Jan 1;372(1):11-20. doi: 10.1056/NEJMoa1411587.
27. Bushnell C, Kernan WN, Sharrief AZ, et al. 2024 guideline for the primary prevention of stroke: a guideline from the American Heart Association/American Stroke Association. Stroke. 2024;55(12):e344-e424. doi: 10.1161/STR.0000000000000475.
28. Ismail A, Ravipati S, Gonzalez-Hernandez D, et al. 2023. Carotid artery stenosis: a look into the diagnostic and management strategies, and related complications. Cureus. 2023;15(5):e38794. doi: 10.7759/cureus.38794 33-41.