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Diagnostic Accuracy of Artificial Intelligence Algorithms for Detecting Large Vessel Occlusion on CT Angiography in Suspected Acute Ischemic Stroke: A Meta-Analysis

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Preliminary searches.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 16 June 2026 and was last updated on 16 June 2026.

INTRODUCTION

Review question / Objective This meta-analysis assesses the diagnostic value of artificial intelligence for intracranial large and medium vessel occlusion detection on CTA in suspected acute ischemic stroke patients, with primary evaluation indicators being pooled sensitivity and specificity.
PICOS framework:
P: Adult patients clinically suspected of acute ischemic stroke who underwent head and neck CT angiography.
I: AI, deep learning or machine learning automated software for vessel occlusion identification on CTA.
C: Manual CTA interpretation by experienced radiologists, or digital subtraction angiography (DSA) as the reference diagnostic gold standard. Manual CTA interpretation by experienced radiologists as the reference diagnostic gold standard.
O: Primary outcomes: pooled sensitivity and specificity; secondary outcomes: AUC and diagnostic odds ratio.
S: Diagnostic test accuracy studies, including single-center, multicenter, real-world and independent external validation studies.
Subgroup analyses will be performed stratified by vascular occlusion types: anterior circulation occlusion and posterior circulation occlusion, to compare the diagnostic performance of AI algorithms across different vascular segments.

Rationale Acute ischemic stroke caused by intracranial large and medium vessel occlusion requires urgent thrombectomy treatment, and rapid and accurate identification of occluded vessels on CTA is critical to optimize emergency triage and improve functional prognosis. Manual interpretation of CTA relies heavily on radiologists' experience, which may lead to diagnostic delays or missed diagnoses during peak emergency periods.

Artificial intelligence algorithms have been widely applied to automatic vessel occlusion detection in recent years, yet individual single studies show inconsistent sensitivity and specificity across different vascular segments and clinical settings. Existing published narrative reviews only qualitatively summarize relevant researches without quantitative pooling of diagnostic indicators, and few prior analyses stratify performance by occlusion location. Notably, anterior circulation lesions covering M2/M3 medium vessels and posterior circulation occlusions differ greatly in imaging features, while the diagnostic accuracy of AI tools for these two categories remains unclear. In addition, real-world and external validation cohorts are under-synthesized in previous summaries, leading to uncertain generalizability of AI software in routine clinical practice. This meta-analysis will quantitatively pool sensitivity and specificity of AI detection tools, and conduct subgroup analyses stratified by anterior circulation occlusion and posterior circulation occlusion. The findings will quantify the overall diagnostic value of AI, clarify performance differences across distinct vascular types, resolve heterogeneity among independent validation studies, and provide reliable evidence for clinicians to select and interpret AI-assisted CTA detection in acute stroke emergency workflows.

Condition being studied Acute ischemic stroke (AIS) triggered by intracranial large and medium vessel occlusion is a severe, time-sensitive neurological emergency. It occurs when blood flow to brain tissue is blocked due to thromboembolism within intracranial arteries, including anterior circulation vessels (internal carotid artery, M1, M2, M3 segments of middle cerebral artery) and posterior circulation vessels (basilar artery, vertebral artery, posterior cerebral artery).
Radiologists rely on manual CTA reading to identify occlusions, yet emergency workload and varying reader experience can cause missed or delayed diagnosis. Artificial intelligence tools are increasingly deployed to automatically screen occluded vessels on CTA, but their diagnostic performance varies between anterior circulation lesions (including M2/M3 medium vessel occlusion) and posterior circulation lesions, which this meta-analysis aims to quantify.

METHODS

Search strategy Electronic databases to be searched: English databases (PubMed/MEDLINE, Embase, Web of Science); Chinese databases (CNKI, Wanfang Data). Search period: database inception to June 16, 2026. English databases restrict records to human studies published in English; no language filters for Chinese databases. Full PubMed search string #1 "stroke"[MeSH] OR "ischemic stroke"[tiab] OR "acute stroke"[tiab]#2 "large vessel occlusion"[tiab] OR "LVO"[tiab] OR "medium vessel occlusion"[tiab] OR "MVO"[tiab] OR "M1"[tiab] OR "M2"[tiab] OR "M3"[tiab] OR "anterior circulation"[tiab] OR "posterior circulation"[tiab]#3 "computed tomography angiography"[MeSH] OR "CTA"[tiab] OR "CT angiography"[tiab] OR "digital subtraction angiography"[MeSH] OR "DSA"[tiab]#4 "artificial intelligence"[MeSH] OR "deep learning"[tiab] OR "machine learning"[tiab] OR "neural network"[tiab] OR "automated detection"[tiab] OR "AI algorithm"[tiab]#5 "sensitivity and specificity"[MeSH] OR "diagnostic accuracy"[tiab] OR "AUC"[tiab] OR "ROC"[tiab]#6 #1 AND #2 AND #3 AND #4 AND #5Filters: English; Humans; from inception to June 16, 2026 Supplementary description for other databases For Embase, Emtree subject headings will replace MeSH terms, with identical free-text synonyms and Boolean logic structure. Chinese databases adopt matched Chinese subject headings and keywords corresponding to the five search blocks above.
Notably, included diagnostic studies may adopt two reference standards: (1) manual CTA interpretation by experienced radiologists, or (2) DSA (digital subtraction angiography) performed during endovascular treatment. Therefore, DSA-related terms are incorporated in search block #3 to capture all relevant trials comparing AI performance against either reference modality.

Participant or population Adult patients clinically suspected of acute ischemic stroke who underwent head and neck CT angiography.

Intervention Artificial intelligence, deep learning or machine learning automatic vessel occlusion detection software on CTA.

Comparator Manual CTA interpretation by experienced radiologists, or digital subtraction angiography (DSA) as the reference diagnostic gold standard.

Study designs to be included Diagnostic test accuracy studies (DTA) are eligible, including prospective, retrospective, single-center, multicenter, real-world and independent external validation researches.

Eligibility criteria Case reports, reviews, conference abstracts without full text, animal experiments and interventional trials will be excluded.

Information sources Electronic bibliographic databases: English databases including PubMed/ MEDLINE, Embase, Web of Science ; Chinese databases including CNKI, Wanfang Data .
Literature will be retrieved from database establishment to June 16, 2026.
Supplementary grey literature screening: Reference lists of all included full-text articles and relevant published systematic reviews will be manually checked to capture missed eligible studies.
Contact with authors: If incomplete diagnostic data (sensitivity, specificity, true/false positive/negative values) are found in included papers, corresponding authors will be emailed to request raw original data.
Trial registers: ClinicalTrials.gov and Chinese Clinical Trial Registry will be searched to identify unpublished completed diagnostic trials.

Main outcome(s) Primary outcomes are pooled sensitivity and pooled specificity of AI-based CTA vessel occlusion detection, synthesized from 2×2 contingency table data of eligible studies.
These two core indicators will be calculated separately in three predefined vascular subgroups: 1) ICA combined with M1 occlusion; 2) ICA+M1 accompanied by M2–M3 medium vessel occlusion; 3) posterior circulation large vessel occlusion, to compare AI diagnostic performance across different lesion segments.
All primary outcomes will be pooled for studies using either radiologist manual CTA interpretation or DSA as reference diagnostic standard.

Additional outcome(s) Subgroup diagnostic metrics will be synthesized separately by vascular occlusion subtypes: 1) ICA combined with M1 segment occlusion; 2) ICA+M1 plus M2–M3 medium vessel occlusion; 3) large vessel occlusion of posterior circulation. Pooled sensitivity, specificity and AUC will be calculated and compared across the three subgroups.
Other supplementary outcomes include I^2 statistic and Cochran's Q test for inter-study heterogeneity, Deeks' funnel plot asymmetry test to assess publication bias, and sensitivity analysis excluding low-quality studies to test result stability. Diagnostic performance will also be contrasted between studies using manual CTA reading and DSA as reference standards.

Data management All search records exported from databases will be imported into NoteExpress for automatic deduplication, with manual inspection afterwards to clear residual duplicates. Two independent reviewers will carry out two rounds of literature screening (title/abstract screening and full-text screening) based on predefined eligibility criteria; inconsistent judgments will be settled through negotiation or consultation with a third senior reviewer.Standard Excel forms will be used to extract 2×2 diagnostic contingency table data (true positive, false positive, true negative, false negative), along with supplementary information including vascular occlusion subtypes, reference standard, study design and AI detection software. Two researchers will cross-validate extracted data to avoid extraction bias.All original extracted data will be saved in encrypted local files. Stata 17 will be adopted to synthesize pooled sensitivity, specificity and AUC. Complete screening logs, extraction spreadsheets and analytical scripts will be preserved to ensure reproducibility of this meta-analysis.

Quality assessment / Risk of bias analysis The QUADAS-2 tool dedicated to diagnostic test accuracy studies will be applied to assess the risk of bias and clinical applicability of all included primary articles.QUADAS-2 contains four bias assessment domains: patient selection, index test, reference standard, and flow and timing. Each domain will be rated as low, unclear, or high risk of bias. Two independent reviewers will complete evaluation separately; discrepancies will be resolved by discussion or arbitration of a third senior researcher.The evaluation results will be presented in risk-of-bias summary and plot figures. Subgroup and sensitivity analyses will be performed to explore whether high-risk studies affect the pooled sensitivity and specificity.

Strategy of data synthesis We will extract complete 2×2 diagnostic table data (true positives, false positives, true negatives, false negatives) from all eligible studies to calculate pooled sensitivity and specificity. Given the anticipated heterogeneity across included trials, we will use the hierarchical summary receiver operating characteristic (HSROC) model rather than a simpler bivariate fixed-effect approach.
Three predefined subgroup analyses will compare AI diagnostic performance by vascular territory: (1) ICA and M1 occlusions only; (2) ICA/M1 plus M2–M3 medium vessel occlusions; (3) posterior circulation large vessel occlusions. Pooled sensitivity, specificity and summary AUC will be reported separately for each subgroup.
Between-study heterogeneity will be evaluated using I^2 statistics and Cochran's Q test. Where substantial heterogeneity is identified, we will perform additional subgroup and sensitivity analyses to explore potential sources. Deeks' funnel plot asymmetry test will assess the risk of publication bias.

To test result robustness, sensitivity analysis will exclude studies rated as high risk of bias under QUADAS-2. All meta-analytic computations will be carried out in Stata version 17.

Subgroup analysis Subgroup analyses will be conducted strictly based on predefined vascular occlusion subtypes to compare the diagnostic performance of AI detection tools. Three subgroups are set: 1) ICA combined with M1 segment occlusion; 2) ICA+M1 occlusion accompanied by M2–M3 medium vessel lesions; 3) posterior circulation large vessel occlusion. Pooled sensitivity, specificity and AUC will be synthesized separately for each subgroup.

All subgroup syntheses will adopt the HSROC model. Differences in diagnostic indicators across subgroups will be compared to explore the influence of lesion location and reference standard on AI detection efficiency. The magnitude of inter-subgroup discrepancy will be interpreted comprehensively combined with heterogeneity results.

Sensitivity analysis Sensitivity analyses will be implemented to verify the stability of pooled diagnostic results. First, studies rated high risk of bias via QUADAS-2 will be excluded to observe changes in overall sensitivity and specificity. Second, separate analyses will be run for studies using only CTA reading as reference standard and those adopting DSA, to check whether different gold standards alter combined outcomes. Third, we will remove small-sample studies to test the robustness of subgroup results across ICA+M1, ICA+M1+M2–M3 and posterior circulation subgroups. All re-analyses adopt the HSROC model; obvious fluctuation of pooled metrics indicates unstable conclusions.

Language restriction English limits for English databases; no language limits for Chinese databases.

Country(ies) involved China.

Keywords Acute ischemic stroke, CTA, large vessel occlusion, artificial intelligence, diagnostic accuracy.

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