INPLASY

Diagnostic Performance of Dual-Energy CT for Differentiating Acute Intracranial Hemorrhage from Contrast Staining: A Systematic Review and Meta-Analysis

INPLASY2025100088
doi: 10.37766/inplasy2025.10.0088
Received: 24 October 2025
Published: 25 October 2025

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ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2025100088

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 25 October 2025 and was last updated on 25 October 2025.

INTRODUCTION

Review question / Objective This systematic review and meta-analysis aims to determine the overall diagnostic accuracy of DECT for this crucial distinction.

Condition being studied Accurate differentiation between acute intracranial hemorrhage (AIH) and contrast staining (CS) on follow-up computed tomography (CT) scans in patients with acute stroke, particularly after endovascular thrombectomy, is a critical clinical challenge. Dual-energy CT (DECT), with its capability for material decomposition, has emerged as a promising solution.

METHODS

Search strategy PubMed:
#1 ((((dual energy[Title/Abstract]) OR (dual source[Title/Abstract])) OR (multi energy[Title/Abstract])) OR (multi source[Title/Abstract])) OR (spectral CT[Title/Abstract])
#2 (Tomography, X-Ray Computed[MeSH Terms]) OR (computed tomography[Title/Abstract]) OR (CT[Title/Abstract])
#3 #1 AND #2
#4 (Intracranial Hemorrhages[MeSH Terms]) OR (intracranial hemorrhage[Title/Abstract]) OR (intracerebral hemorrhage[Title/Abstract]) OR (subarachnoid hemorrhage[Title/Abstract])
#5 (brain[Title/Abstract]) OR (cerebral[Title/Abstract]) OR (intracranial[Title/Abstract])
#6 (hemorrhage[Title/Abstract]) OR (haemorrhage[Title/Abstract]) OR (bleed[Title/Abstract]) OR (OR ("contrast staining"[Title/Abstract]) OR ("contrast extravasation"[Title/Abstract])
#7 #5 AND #6
#8 #4 OR #7
#9 ((((("diagnostic accuracy"[Title/Abstract]) OR (sensitivity[Title/Abstract])) OR (specificity[Title/Abstract])) OR ("ROC curve"[Title/Abstract])) OR ("area under the curve"[Title/Abstract])
#10 (Sensitivity and Specificity[MeSH Terms]) OR (ROC Curve[MeSH Terms])
#11 #9 OR #10

#12 #3 AND #8 AND #11

EmBase:
1. (dual energy or dual source or multi energy or multi source or spectral ct).ab,ti.
2. exp *dual energy computed tomography/ or exp *computer assisted tomography/
3. 1 or 2
4. (brain or cerebral or intracranial or intracerebral).ab,ti.
5. exp *brain/ or exp *intracranial hemorrhage/
6. 4 or 5
7. (hemorrhage or haemorrhage or bleed or differentiat* or distinguis* or "contrast staining" or calcification).ab,ti.
8. exp *brain hemorrhage/
9. 7 or 8
10. ("diagnostic accuracy" or sensitivity or specificity or "roc curve" or "area under the curve" or "receiver operating characteristic").ab,ti.
11. exp *"sensitivity and specificity"/ or exp *"receiver operating characteristic"/
12. 10 or 11
13. 3 and 6 and 9 and 12

Cochrane Library:
#1 MeSH descriptor: [Tomography, X-Ray Computed] explode all trees
#2 (dual energy OR dual source OR multi energy OR multi source OR "spectral CT"):ti,ab,kw
#3 #1 OR #2
#4 MeSH descriptor: [Intracranial Hemorrhages] explode all trees
#5 MeSH descriptor: [Brain] explode all trees
#6 (brain OR cerebral OR intracranial OR intracerebral):ti,ab,kw
#7 #4 OR #5 OR #6
#8 MeSH descriptor: [Hemorrhage] explode all trees
#9 (hemorrhage OR haemorrhage OR bleed OR differentiat* OR distinguis* OR "contrast staining" OR calcification):ti,ab,kw
#10 #8 OR #9
#11 MeSH descriptor: [Sensitivity and Specificity] explode all trees
#12 MeSH descriptor: [ROC Curve] explode all trees
#13 ("diagnostic accuracy" OR sensitivity OR specificity OR "ROC curve" OR "area under the curve"):ti,ab,kw
#14 #11 OR #12 OR #13
#15 #3 AND #7 AND #10 AND #14

Web of Science:
#1 TS=((dual energy OR dual source OR multi energy OR multi source OR "spectral CT") AND (computed tomography OR CT))
#2 TS=(brain OR cerebral OR intracranial OR intracerebral)
#3 TS=((hemorrhage OR haemorrhage OR bleed) AND (differentiat* OR distinguis* OR "contrast staining"))
#4 TS=("diagnostic accuracy" OR sensitivity OR specificity OR "ROC curve" OR "area under the curve" OR "receiver operating characteristic")
#5 #1 AND #2 AND #3 AND #4.

Participant or population Patients with clinically suspected AIH and possible CS (e.g., after contrast-enhanced CT or post-endovascular treatment follow-up), with no restrictions on age, sex, or etiology.

Intervention Use of DECT technology, irrespective of specific scanning parameters or post-processing methods (e.g., iodine maps, virtual non-contrast images).

Comparator Confirmation via follow-up imaging, surgical/pathological findings, or clinical follow-up outcomes.

Study designs to be included Diagnostic studies.

Eligibility criteria The inclusion criteria were: (1) Study type: published diagnostic test accuracy studies evaluating both DECT and a reference standard for differentiating AIH from CS; (2) Population: patients with clinically suspected AIH and possible CS (e.g., after contrast-enhanced CT or post-endovascular treatment follow-up), with no restrictions on age, sex, or etiology; (3) Index test: use of DECT technology, irrespective of specific scanning parameters or post-processing methods (e.g., iodine maps, virtual non-contrast images); (4) Reference standard: confirmation via follow-up imaging, surgical/pathological findings, or clinical follow-up outcomes; and (5) Outcomes: provision of extractable data for constructing a 2×2 diagnostic contingency table (true positives, false positives, true negatives, false negatives) or directly reported sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), or area under the receiver operating characteristic curve (AUC).

Information sources PubMed, Embase, the Cochrane Library, and Web of Science.

Main outcome(s) Provision of extractable data for constructing a 2×2 diagnostic contingency table (true positives, false positives, true negatives, false negatives) or directly reported sensitivity, specificity, positive likelihood ratio (PLR), negative

likelihood ratio (NLR), or area under the receiver operating characteristic curve (AUC).

Quality assessment / Risk of bias analysis The methodological quality and risk of bias of the included studies were assessed independently by two investigators using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) tool.

Strategy of data synthesis All pooled estimates were derived using a bivariate generalized linear mixed model with random effects.

Subgroup analysis To explore potential sources of heterogeneity, pre-specified subgroup analyses were conducted based on publication year, country, study design, patient age, and sex ratio.

Sensitivity analysis NA.

Language restriction No restriction.

Country(ies) involved China.

Keywords acute intracranial hemorrhage; contrast staining; dual-energy CT; diagnostic performance; systematic review.

Contributions of each author
Author 1 - Wenbin Ji.
Author 2 - Yaosheng Shi.