

ROLE OF CT IN RARE ABDOMINAL VASCULAR PATHOLOGIES WITH CLINICAL AND SURGICAL CONSIDERATIONS: A PROSPECTIVE CASE SERIES

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ABSTRACT

Background: Rare abdominal vascular pathologies can produce overlapping clinical presentations and require rapid anatomical definition before treatment. **Objective:** To evaluate the diagnostic performance of multiphasic contrast-enhanced computed tomography (CT) in uncommon abdominal vascular pathologies and describe its clinical and surgical implications.

Methods: In this prospective case series, 50 adults with suspected abdominal vascular pathology underwent arterial-, venous-, and delayed-phase CT angiography on a 128-slice scanner. Two radiologists performed a structured review. The reference standard was surgical or interventional confirmation when available; otherwise, a composite of clinical findings, laboratory results, follow-up imaging, and multidisciplinary consensus was used. Category-wise sensitivity and specificity were calculated in a one-versus-rest framework.

Results: The cohort included 32 men and 18 women (mean age, 52.3 ± 15.6 years). CT identified aneurysm in 15 patients, stenosis in 12, thrombosis in 10, dissection in 8, and vascular malformation in 5. Sensitivity ranged from 80.0% to 93.3%, and specificity ranged from 97.1% to 97.8%. Clinical or laboratory findings supported the CT diagnosis in 38 patients, and surgical or interventional confirmation was available in 35. CT findings influenced operative or interventional planning in 22 patients, with early successful outcomes documented in 20.

Conclusion: Multiphasic CT provided clinically useful diagnosis and treatment mapping by defining lesion morphology, vascular inflow and outflow, branch-vessel involvement, active extravasation, collateral pathways, and relationships with bowel or solid organs.

Keywords: Abdominal vascular pathology, Case series, Clinical correlation, Computed tomography, CT angiography, Surgical planning

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INTRODUCTION

Rare abdominal vascular pathologies comprise a heterogeneous group of uncommon but clinically important conditions. Aneurysms, dissections, vascular stenoses, arterial or venous thromboses, arteriovenous malformations, portosystemic shunts, aortoenteric fistulas, and collateral-vessel aneurysms may present with abdominal pain, gastrointestinal bleeding, weight loss, hypertension, hematuria, cyanosis, or biochemical evidence of ischemia. These manifestations overlap with more common gastrointestinal, renal, hepatobiliary, and inflammatory disorders and can delay diagnosis.

A delayed vascular diagnosis may result in bowel infarction, aneurysm rupture, hemorrhagic shock, organ ischemia, renal dysfunction, or loss of an opportunity for minimally invasive therapy. Imaging must therefore do more than detect a lesion; it should provide a treatment map for radiologists, vascular surgeons, gastrointestinal surgeons, and interventional teams.

Multidetector CT and CT angiography provide rapid acquisition, high spatial resolution, multiplanar reconstruction, maximum-

intensity projection, and three-dimensional vascular display. These capabilities can demonstrate arterial narrowing, aneurysmal dilatation, mural thrombus, dissection flaps, venous thrombosis, abnormal shunting, collateral pathways, active contrast extravasation, and associated bowel or solid-organ abnormalities within one examination.¹

Evidence from multidetector CT studies supports the diagnostic value of CT in suspected acute mesenteric ischemia, and updated emergency-surgery guidance emphasizes prompt CT angiographic evaluation when this diagnosis is considered.^{2,3}

CT angiography also has an established role in acute gastrointestinal bleeding because it can localize active bleeding, display vascular anatomy, and support endovascular triage.⁴

In abdominal aortoiliac aneurysmal disease, CT helps define sac morphology, branch-vessel involvement, thrombus burden, signs of rupture, access-vessel suitability, and the feasibility of open or endovascular repair.⁵

For visceral artery aneurysms, management depends on the artery of origin, lesion diameter, rupture status, inflow and outflow vessels, organ perfusion, and collateral pathways.⁶

Existing literature largely addresses individual vascular entities or specific emergency indications. The novelty of the present study was the prospective application of a uniform multiphasic CT protocol and structured interpretation across a heterogeneous spectrum of rare arterial, venous, shunt, and fistulous abdominal vascular abnormalities, with explicit linkage of imaging findings to surgical or interventional planning.

MATERIALS AND METHODS

Study Design, Setting, and Participants

This prospective case series was conducted in the Department of Radiology, Saveetha Medical College and Hospital, SIMATS Deemed University, Chennai, India, from March 2024 to March 2025. Institutional ethical approval was obtained from the Saveetha Research Board before data collection (approval number 562/03/2024/PG/SRB/SMCH).

Fifty patients with clinical or preliminary sonographic suspicion of rare abdominal vascular pathology were enrolled. Eligible participants were 18-75 years of age and had suspected abdominal vascular anomaly, aneurysm, stenosis, dissection, thrombosis, shunt, fistula, or vascular malformation. Pregnancy, renal insufficiency, a previous severe reaction to iodinated contrast material, and other contraindications to contrast-enhanced CT were exclusion criteria.

Because this was an exploratory study of heterogeneous rare conditions, no formal power calculation was performed. The study used a pragmatic sample of 50 eligible patients recruited during the predefined study period; category-specific diagnostic estimates were therefore considered descriptive and exploratory.

CT Acquisition Protocol

All patients underwent contrast-enhanced abdominal CT on a Siemens 128-slice scanner. Iodixanol was administered intravenously at 1.5 mL/kg through a power injector at 4-5 mL/s, followed by a 30-40 mL saline flush. The protocol included arterial, venous, and delayed acquisitions.

The arterial phase began 20-30 seconds after initiation of contrast injection and used 128 × 0.6 mm collimation, 120 kV, 250 mAs, 1.0 mm slice thickness, and a 0.5 mm reconstruction interval. The venous phase was acquired at approximately 60-70 seconds using the same collimation and 200 mAs. The delayed phase was obtained 5-10 minutes after contrast administration using 150 mAs, 1.5 mm slice thickness, and a 1.0 mm reconstruction interval.

Multiplanar, maximum-intensity-projection, and volume-rendered reconstructions were generated as required. Arterial-phase images were used primarily to evaluate aneurysm, stenosis, dissection, active extravasation, and arterial inflow. Venous- and delayed-phase images were used to assess venous thrombosis, vascular malformation, shunting, parenchymal perfusion, delayed enhancement, and relationships with adjacent organs.

Image Interpretation and Reference Standard

Two experienced radiologists independently reviewed the CT examinations. They documented lesion location, involved vessel, arterial inflow, venous outflow, luminal narrowing, aneurysm morphology, dissection flap, mural thrombus, arterial or venous filling defects, contrast extravasation, collateral pathways, organ perfusion abnormalities, bowel-wall changes, and surgically relevant branch-vessel relationships. Disagreements were resolved by consensus, and each patient was assigned a principal pathology category for analysis.

The reference standard was hierarchical. Surgical or interventional findings were used when available. For patients without procedural confirmation, a composite reference standard incorporating clinical findings, laboratory results, follow-up imaging, and multidisciplinary consensus was used.

Outcome Measures and Statistical Analysis

The primary outcome was the ability of CT to identify and characterize rare abdominal vascular pathology. Secondary outcomes were clinical or laboratory correlation, surgical or interventional confirmation, influence on treatment planning, and documented early outcome after CT-guided management.

Data were analyzed using IBM SPSS Statistics, version 25.0. Continuous variables were summarized as mean ± standard deviation, and categorical variables as frequency and percentage. For each principal pathology category, CT classification was compared with the reference standard in a one-versus-rest analysis. True-positive (TP), false-positive (FP), false-negative (FN), and true-negative (TN) counts were recorded. Sensitivity was calculated as TP/(TP + FN), and specificity as TN/(TN + FP); TN was derived as N - TP - FP - FN. Values were rounded to one decimal place. Because of the exploratory design and small subgroups, the analysis was descriptive; no formal hypothesis testing or receiver operating characteristic analysis was performed.

Ethical Considerations

Written informed consent was obtained before participation. Patient confidentiality was maintained during image review and manuscript preparation. The study followed institutional research-ethics requirements and the principles of the Declaration of Helsinki.

RESULTS

Patient Profile

The case series included 50 patients aged 18-75 years; the mean age was 52.3 ± 15.6 years. There were 32 men (64.0%) and 18 women (36.0%). Clinical or laboratory findings supported the CT diagnosis in 38 patients (76.0%), and surgical or interventional confirmation was available in 35 (70.0%). Baseline and confirmation characteristics are summarized in Table 1.

Table 1. Baseline and confirmation profile of the case series

Variable	Finding
Study design	Prospective exploratory case series with descriptive diagnostic-performance analysis
Study setting	Department of Radiology, Saveetha Medical College and Hospital, SIMATS Deemed University, Chennai, India
Study period	March 2024 to March 2025
Sample size	50 patients
Age	18-75 years; mean 52.3 ± 15.6 years
Sex	32 men (64.0%) and 18 women (36.0%)
Reference standard	Surgical/interventional findings when available; otherwise, composite clinical, laboratory, follow-up imaging, and multidisciplinary assessment
Clinical/laboratory correlation	38 patients (76.0%)
Surgical/interventional confirmation	35 patients (70.0%)

Phase-Specific Contribution of CT

Arterial, venous, and delayed datasets made complementary contributions to interpretation. Arterial-phase imaging was most useful for aneurysm, stenosis, dissection, collateral mapping, and active bleeding. Venous-phase imaging improved assessment of

thrombosis, venous congestion, vascular malformation, and organ perfusion. Delayed-phase imaging helped evaluate persistent enhancement, late extravasation, ischemic organ change, and selected shunt-related findings (Table 2).

Table 2. Phase-specific diagnostic contribution of multiphasic CT

CT phase	Principal diagnostic contribution
Arterial phase	Aneurysm, stenosis, dissection, active extravasation, collateral pathways, and arterial inflow mapping
Venous phase	Thrombosis, venous congestion, vascular malformation, bowel and organ perfusion, and venous outflow mapping
Delayed phase	Persistent or delayed enhancement, late extravasation, ischemic organ change, and selected shunt-related findings

Spectrum of Rare Abdominal Vascular Pathology

Aneurysm was the most frequent principal CT-defined pathology, occurring in 15 patients (30.0%). Stenosis was identified in 12 (24.0%), thrombosis in 10 (20.0%), dissection in 8 (16.0%), and

vascular malformation in 5 (10.0%). Category distribution and diagnostic-performance values are presented in Table 3 and Figure 1.

Table 3. Distribution and diagnostic performance of CT-defined pathology categories

Pathology category	CT-detected, n (%)	TP / FP / FN / TN	Sensitivity, %	Specificity, %
Aneurysm	15 (30.0)	14 / 1 / 1 / 34	93.3	97.1
Stenosis	12 (24.0)	11 / 1 / 1 / 37	91.7	97.4
Thrombosis	10 (20.0)	9 / 1 / 1 / 39	90.0	97.5
Dissection	8 (16.0)	7 / 1 / 1 / 41	87.5	97.6
Vascular malformation	5 (10.0)	4 / 1 / 1 / 44	80.0	97.8

Note: TP, true positive; FP, false positive; FN, false negative; TN, true negative. Each category was analyzed against all other categories. Sensitivity = TP/(TP + FN); specificity = TN/(TN + FP).

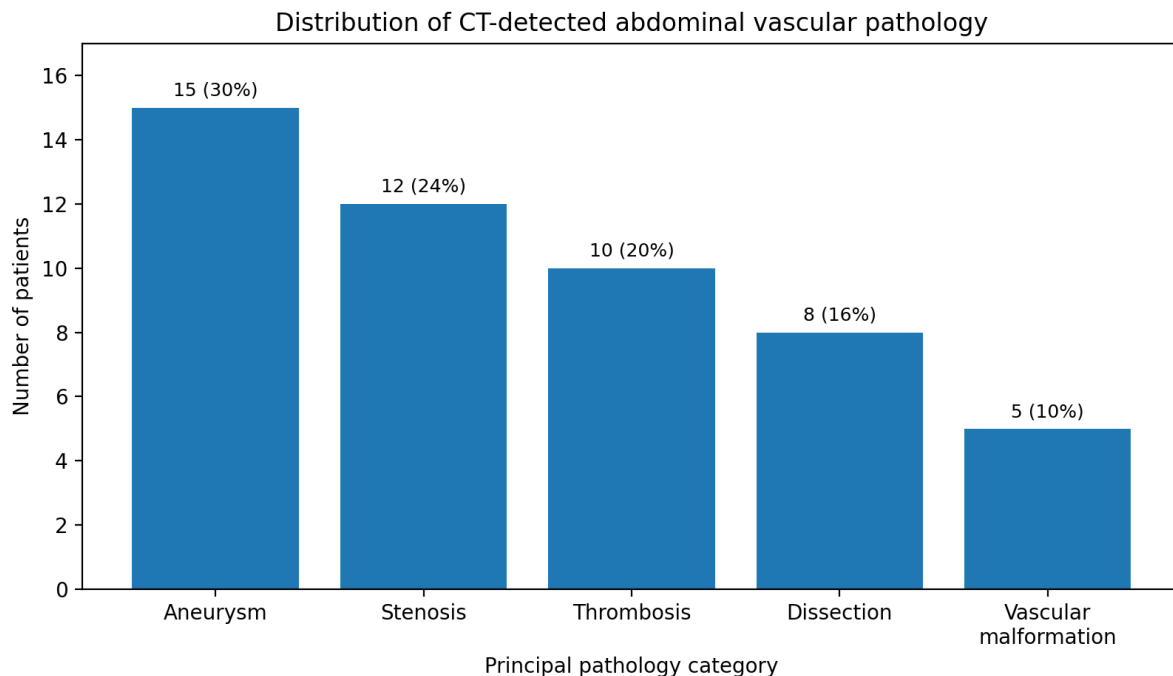


Figure 1. Distribution of CT-detected rare abdominal vascular pathology categories in the 50-patient case series.

Diagnostic Performance

CT showed high category-specific diagnostic performance. Sensitivity was 93.3% for aneurysm, 91.7% for stenosis, 90.0% for thrombosis, 87.5% for dissection, and 80.0% for vascular

malformation. After recalculation from the reported TP, FP, and FN counts, specificity ranged from 97.1% for aneurysm to 97.8% for vascular malformation (Figure 2).

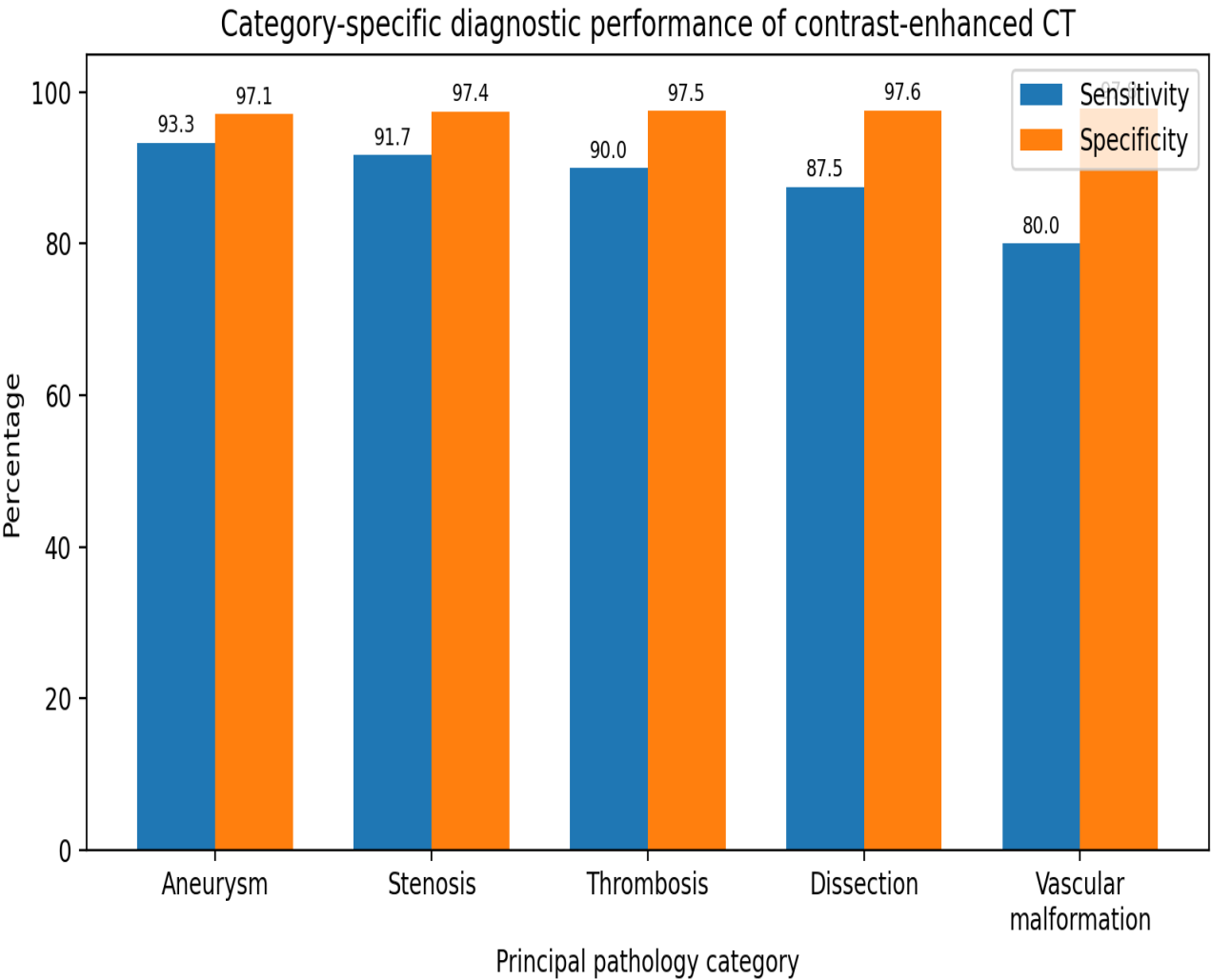


Figure 2. Sensitivity and specificity of contrast-enhanced CT across the principal rare abdominal vascular pathology categories.

Clinical and Surgical Implications

CT findings influenced clinical management and operative or interventional planning in 22 patients. Early successful outcomes

were documented in 20 of these patients (90.9%). The principal CT patterns and their clinical and management relevance are summarized in Table 4.

Table 4. CT patterns and clinical-management relevance

CT-defined pattern	Key CT findings	Clinical and management relevance
Aneurysm	Sac size and morphology; mural thrombus; rupture signs; branch-vessel relationship	Explains pain, pulsatile mass, bleeding, or incidental aneurysm; supports surveillance, open repair, endovascular repair, and landing-zone assessment
Stenosis	Ostial or segmental narrowing; collateralization; organ perfusion change	Supports ischemic or renovascular symptoms; guides revascularization, stenting feasibility, and conservative triage
Dissection	Intimal flap; true and false lumen; longitudinal extension; branch compromise	Identifies malperfusion risk and urgency; guides vascular-surgical consultation and endovascular planning
Thrombosis	Arterial or venous filling defect; bowel-wall change; venous congestion; organ infarction	Correlates with acute pain and ischemic markers; guides anticoagulation, thrombectomy, thrombolysis, and bowel-viability assessment
Vascular malformation	Feeding artery; nidus; draining vein; shunt pathway; organ involvement	Explains bleeding, venous hypertension, cyanosis, or mass effect; supports embolization, covered-stent use, staged therapy, or observation

Representative CT Findings

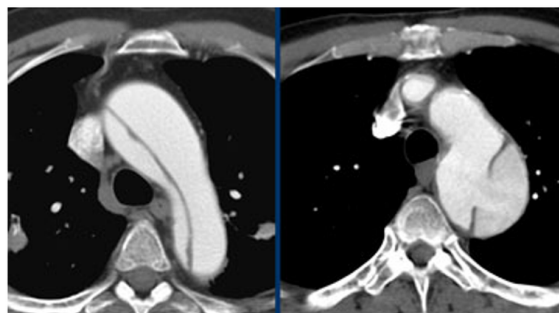
Representative images demonstrate the practical spectrum of disease in the study, including abdominal aortic aneurysm, aortic

dissection, bilateral renal artery stenosis, and complex aneurysmal vascular pathology with clinically suspected fistulous communication (Figure 3).

A



B



C



D

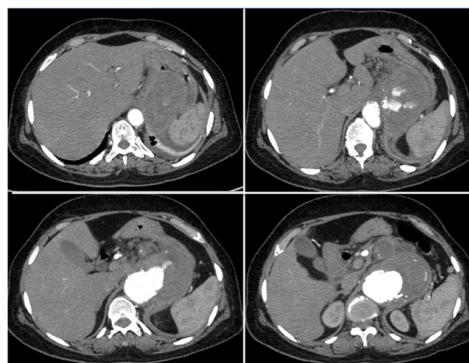


Figure 3. Representative contrast-enhanced CT findings: (A) abdominal aortic aneurysm with mural thrombus; (B) aortic dissection with an intimal flap; (C) bilateral renal artery stenosis; and (D) complex aneurysmal abdominal vascular pathology with suspected fistulous communication.

Case-Based Radiological Observations

In the aneurysm group, CT depicted sac morphology, mural thrombus, wall calcification, branch-vessel relationships, and features relevant to rupture. For abdominal aortic aneurysm, these findings helped define operative feasibility and endovascular suitability.

In the stenosis group, CT demonstrated ostial or segmental narrowing and collateral pathways. Renal artery and mesenteric inflow stenoses were clinically relevant because the findings correlated with renovascular or ischemic symptoms and informed decisions about further vascular assessment or intervention.

In the dissection group, CT demonstrated the intimal flap, true and false lumina, longitudinal extension, and branch-vessel compromise, permitting rapid risk stratification and vascular-surgical referral.

In the thrombosis group, arterial or venous filling defects were assessed together with bowel-wall thickening, perfusion abnormality, venous congestion, and organ infarction. CT thereby informed decisions about anticoagulation, thrombolysis, thrombectomy, and bowel-viability assessment.

In the vascular-malformation group, CT demonstrated abnormal enhancement, feeding vessels, draining veins, shunting, nidus-like vascular channels, and organ involvement. In shunt-like lesions, the vascular map helped identify potential endovascular access routes and supported consideration of embolization or covered-stent placement.

DISCUSSION

This prospective case series showed that multiphasic contrast-enhanced CT provided a practical pathway for evaluating rare abdominal vascular pathologies. Its contribution extended beyond

lesion detection to an anatomical roadmap for surgery, endovascular therapy, conservative management, or follow-up.

Aneurysm and stenosis were the most frequently detected patterns. Aneurysm had the highest sensitivity, plausibly because luminal contrast filling, sac dilatation, wall calcification, thrombus, and multiplanar reconstruction collectively improved lesion delineation. Vascular malformation had the lowest sensitivity, likely reflecting heterogeneous shunt morphology, slow-flow venous components, nidus-like channels, and overlap with nonvascular masses.

The findings support inclusion of an arterial phase whenever abdominal vascular pathology is suspected. Arterial-phase imaging demonstrated aneurysm, stenosis, active extravasation, intimal flaps, and arterial collateralization. Venous-phase images contributed to assessment of thrombosis, bowel perfusion, portal venous abnormalities, and organ enhancement, while delayed images helped characterize persistent pooling, delayed enhancement, and parenchymal involvement.

Clinical value depended not only on diagnosis but also on the anatomical information provided. The arc of Riordan example in the study material illustrated how a collateral pathway can enlarge in chronic mesenteric occlusive disease and become clinically important when aneurysmal change or rupture risk develops.

Endovascular treatment of visceral and collateral aneurysms may require exclusion of both inflow and outflow because collateral backfilling can maintain sac pressurization after incomplete embolization.⁷

The aortoenteric-fistula example emphasized the role of CT in life-threatening gastrointestinal bleeding. Diagnostic confidence increases when CT demonstrates loss of the fat plane between bowel and aorta, focal bowel-wall thickening over an aneurysm,

ectopic gas, perigraft or periaortic inflammatory change, or direct contrast communication with the gastrointestinal tract.⁸

Vascular malformations and shunt-like lesions require precise terminology and vascular mapping. Standardized classification can prevent vague labeling, while CT defines arterial supply, venous drainage, nidus, organ involvement, and potential endovascular access.⁹

CT angiography is also important after endovascular aneurysm repair because it can demonstrate endoleak, graft migration, occlusion, infection, rupture, and other treatment-related complications.¹⁰

Dedicated multidetector CT protocols for abdominal aortic aneurysm assessment use multiplanar reconstruction and CT angiography to clarify aneurysm-neck morphology, branch arteries, mural thrombus, calcification, and access vessels.¹¹

Appropriateness guidance for mesenteric ischemia likewise supports CT angiography as a key imaging examination when acute or chronic mesenteric ischemia is suspected, reinforcing the need to tailor the protocol to the clinical question and vascular territory.¹²

This study has limitations. The sample was modest and several pathology groups were small, so category-specific estimates are imprecise and should be interpreted as exploratory. Surgical or interventional confirmation was unavailable for every patient; use of a composite reference standard introduced partial-verification and potential incorporation bias. CT was not directly compared with Doppler ultrasound, MR angiography, catheter angiography, or intraoperative angiography. Radiation exposure and iodinated-contrast risk also remain relevant, particularly in younger patients and those with renal impairment.

Despite these limitations, the findings emphasize the practical role of CT as a first-line problem-solving examination when rare abdominal vascular pathology is suspected. Its principal strength is the integration of diagnosis, anatomical mapping, complication detection, and immediate surgical or interventional planning.

CONCLUSION

Multiphasic contrast-enhanced CT demonstrated clinically useful diagnostic and treatment-planning performance across rare abdominal vascular pathologies. It characterized aneurysm, stenosis, dissection, thrombosis, vascular malformation, collateral aneurysm, and fistulous vascular communication and influenced operative or interventional decisions in 22 of 50 patients. Larger multicenter studies using uniform, independent reference standards are needed to define performance for individual rare vascular entities.

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DATA AVAILABILITY

The datasets generated during the study are available from the corresponding author on reasonable request and subject to institutional approval.

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