ELSEVIER

Check for updates

Clinical Research

Evaluating the Accuracy and Reliability of Splenic Artery Aneurysm Assessment on Computed Tomography Imaging

Robert J. Leatherby,[1,2] ChunHei Li,[1,2] Adelola Oseni,[3] Rose Howroyd,[3] James Budge,[1,2] Peter Holt,[1,2] and Iain Roy,[1,2] London, UK

Background: Splenic artery aneurysms (SAAs) are the third most common abdominal arterial aneurysm. Several radiological features have been associated with their growth rate and rupture risk. We aim to evaluate the accuracy and reliability in assessing these features on computed tomography scans.

Methods: Radiological reports were searched for scans positive for SAA between 2012 and 2021 inclusive. These scans were assessed with our novel radiological proforma by 2 radiologists to determine those criteria which were reliably reported. A nonexpert was then compared against this baseline to assess the reliability of SAA assessment by nonradiologists. Pearson and Spearman rank correlation coefficients and Cohen Kappa statistics was used to assess agreement.

Results: A cohort of 170 scans was assessed. A high degree of agreement (correlation coefficient $r = 0.89-0.91$) was achieved by radiologists for SAA diameter measurement. A high level of agreement was also achieved for calcification (Kappa = 0.827) and previous intervention (1.0), moderate agreement for presence of SAA (0.563), calcification percentage (0.563), morphology (0.446), and presence of thrombus (0.516). Rupture and pseudoaneurysm morphology demonstrated poor agreement (Kappa <0.01) but were rare events limiting interpretation. A nonexpert could achieve comparable diameter measurements ($P < 0.05$) but had consistently lower kappa agreements for all aneurysm characteristics compared to radiologists.

Conclusion: Aneurysm diameter, calcification, and previous intervention were the only features reported with high agreement between radiologists. Other SAA characteristics only achieved moderate or poor agreement and so should be used with caution in research and clinical settings.

Robert J Leatherby and ChunHei Li contributed equally to this work.

The authors declare that they have no conflict of interest.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Approval was sought and obtained from the UK Health Research Authority and Research Ethics Committee.

[1]*St George's Vascular Institute, St George's University Hospital NHS Foundation Trust, London, UK.*

[2]*School of Health & Medical Sciences, City St George's University of London, London, UK.*

[3]*Interventional Radiology Department, St George's University Hospital NHS Foundation Trust, London, UK.*

Correspondence to: Robert J. Leatherby, BSc, MBBS, MRCS, St George's Vascular Institute - St George's University Hospital NHS Foundation Trust, Blackshaw Road, London SW17 0QT, UK; E-mails: Rleather@sgul.ac.uk or Robert.Leatherby.09@gmail.com or Robert.Leatherby@stgeorges.nhs.uk

Ann Vasc Surg 2026; 122: 438–446
https://doi.org/10.1016/j.avsg.2025.07.040

Manuscript received: May 1, 2025; manuscript accepted: July 28, 2025; published online: 14 August 2025

INTRODUCTION

Splenic artery aneurysms (SAAs) are the third most common type of abdominal arterial aneurysm following those of the aorta (AAA) and iliac vessels. They are the most common visceral artery aneurysm, accounting for an estimated 60% of the total.[1] The risk is that of rupture, which is rare but carries a high risk of mortality at around 40%.[2]

There are 2 sets of current guidelines for the management of SAAs provided by the European Society of Vascular Surgeons (ESVS) and the Society of Vascular Surgeons (SVS).[3,4] The guidelines agree that all patients with symptomatic aneurysms, pseudoaneurysms and SAAs in women of childbearing age should be considered for repair regardless of size. The management of asymptomatic SAAs however differs, with ESVS suggesting a threshold of 25 mm for repair and 2−3 yearly surveillance for those below threshold, compared to SVS who advise a higher 30 mm threshold but more intensive surveillance with annual scans. All these recommendations however are weak, based upon moderate quality evidence. The majority of SAA intervention is now endovascular, and whilst technical success is very high at 90%, patient selection is key given known complications such as postembolization syndrome and splenic ischemia occurring in 30%−40% of cases.[5−7]

Additional to size and pseudoaneurysmal morphology, other characteristics have been shown to be associated with growth and rupture risk. Wall calcification is negatively correlated with growth, whereas index aneurysm size and thrombus burden are positively correlated.[8] Aneurysm morphology is an important risk factor for growth in AAAs, but there is currently insufficient evidence for SAAs.[9]

Most SAAs are asymptomatic and identified on cross-sectional imaging for other purposes. The SVS recommend computed tomography (CT) as the diagnostic tool of choice for SAAs,[4] and it is often the modality in which SAAs are incidentally found and surveyed. Additionally, CT is also the imaging modality utilized in much of the contemporary research assessing the natural history of SAAs and their surveillance.[8,10] It is therefore key that we ensure future guidelines are based upon research investigating radiological features of SAA that can be evaluated accurately and reliably between observers.

Similar work has been conducted in other related areas of vascular surgery, including the assessment of infrarenal AAAs[11] and type B aortic dissections.[12] Standardized reporting protocols have been developed for these conditions to be used in both clinical and research settings. Their aim is to improve the recognition of important prognostic variables, standardize the format of reporting to allow interstudy comparison and highlight which features may be challenging to evaluate reliably.

Our primary objective was to determine which features of SAA, determined by previous studies as clinically important, can be accurately and reliably assessed on CT. Additionally we aimed to investigate whether a nonexpert doctor could reliably assess SAAs on CT, and whether a simplification of SAA measurement from multiplanar assessment to axial only measurement could be justified.

MATERIALS AND METHODS

Protocol Design

A review of the contemporary literature was performed. Features which were consistently identified in the literature,[8,9] those incorporated into existing guidelines[3,4] and further features deemed to be of probable importance based on local expertise were included in the protocol design. Nine features were included in the final protocol for assessment of their accuracy and reliability.

1. Presence of an SAA
2. Diameter of SAA (anteroposterior (AP), transverse and craniocaudal (CC) planes)
3. Presence of thrombus
4. Presence and degree of wall calcification
5. Pseudoaneurysmal morphology
6. Fusiform or saccular morphology
7. Previous intervention
8. Evidence of rupture
9. Size of normal, proximal splenic artery

In addition to the above, the use of intravascular contrast was noted along with the phasing of the scan.

Study Design

This study was performed as a retrospective cohort investigation conducted at a single high-volume tertiary vascular center. Ethical approval was obtained through the Health Research Authority and Research Ethics Committee.

Patients were identified through a comprehensive search of the local radiological reporting database. This ''picture archiving and communication system'' (PACS) was searched from 2012 to 2021 inclusive. The search strategy is detailed in supplementary data 1.

To interrogate the validity of this search method, we utilized the String-R tool,[13] see supplementary data 2 for details. The high frequency of the word aneurysm adjacent to splenic artery (84.6%) adds validity to the specificity of the search strategy utilized.

Radiological Measurements

Each identified SAA underwent assessment by 2 independent radiologists. Maximal diameters were obtained from 3 views utilizing multiplanar reconstructed (MPR) CT imaging in axial, coronal, and sagittal planes. Maximum aneurysm diameters were defined from the outer edge of the vessel. The presence of thrombus within the aneurysm sac was identified visually and defined as a binary measure. Wall calcification was also identified visually and was additionally categorized into 5 groups based on percentage (none, <25%, 26−50%, 51−75%, >75%). Pseudoaneurysmal morphology was identified visually alongside the incorporation of concurrent etiological pathologies such as pancreatitis or trauma. Fusiform aneurysms were defined as symmetrical dilatation of the entire vessel, with those not fitting these criteria being termed saccular. Previous intervention was identified by the presence of previous endovascular intervention in the form of stents or embolization. The size of normal splenic artery was measured at 1 cm from the origin (defined as the bifurcation of the splenic artery from the celiac trunk), unless it was aneurysmal at this site in which case the closest non aneurysmal diameter of artery to its origin was utilized. The presence and phase of intravascular contrast were also noted.

Assessment of Interobserver Variability

Comparison was made between the 2 radiologists. Interobserver variation was assessed utilizing a Kappa statistic to ascertain agreement. This variability was then set as the reference standard. The radiologists then taught a nonexpert doctor (postgraduate year 2 (UK foundation level) with 4 months clinical exposure to vascular surgery) to assess SAAs according to the protocol. These values were then compared to the radiologists with Kappa values generated to assess the reproducibility of SAA assessment by a nonexpert.

Statistical Analysis

The Pearson correlation coefficient was employed to compute *P* values for parametric continuous variables, while the Spearman Rank correlation coefficient was used for nonparametric continuous variables. For categorical data, the Cohen's Kappa value was calculated to assess the rank correlation of intervariability and Fisher exact test was used for discrepant case analysis. The statistical analysis was performed using R statistical program.[14] A *P* value <0.05 was considered statistically significant.

TABLE I. Patient demographics

Patient characteristic	Mean (SD)
Age	71.0 (14.1)
	N (%)
Female	124 (72.9)
HTN	73 (42.9)
pHTN or liver cirrhosis	7 (4.1)
DM	26 (15.3)
IHD	23 (13.5)
Coexisting aneurysm/ dissection	22 (12.9)
PAD	6 (3.5)

DM, diabetes mellitus; HTN, hypertension; IHD, ischemic heart disease; pHTN, portal hypertension, PAD, peripheral arterial disease.

RESULTS

A total of 350 CT scans were initially identified using the search strategy. After deduplication 213 unique patients were identified. The scan reports were then analyzed leading to the exclusion of 43 scans which did not mention the presence of an SAA. Therefore, a final cohort of 170 patients was taken forward to analysis. There were 115 cases of confirmed SAA with a reported size, 45 cases of SAA without measurement and 10 cases of suspected SAA according to the radiologist report. The cohort was predominantly female (72.9%) and elderly, with a mean age of 71 years. Full patient demographics are detailed in Table I.

Aneurysm Characteristics

Aneurysm characteristics were based upon the protocolized assessment performed by 2 radiologists. Of the 170 scans assessed 149 were deemed to be diagnostic of SAA with 8 deemed not to show an SAA. The remaining 13 scans had differing interpretations.

These 149 scans with confirmed SAA by 2 radiologists were then taken forward to assess for the remaining SAA characteristics. Calcification was present in 126 patients and absent in 17, with disagreement between radiologists for the remaining 6. No scans were positively identified to show

TABLE II. Radiologist assessment of aneurysm characteristics

Aneurysm characteristic	Yes	No	Disagreement	Not applicable[a]
Splenic artery aneurysm present	149	8	13	0
Is there calcification	126	17	6	21
Is there bleeding or rupture	0	147	2	21
Is there a pseudoaneurysm	0	147	2	21
Is there thrombus	33	78	31	28
Previous intervention	1	148	0	21
Saccular aneurysm	130	6	12	22

[a]Not applicable reasons include − no SAA identified, non-contrast scan ($n = 7$) and ruptured SAA ($n = 1$).

bleeding/rupture or pseudoaneurysm by both radiologists and there were 2 disagreements in both categories. Thrombus was identified in 33 scans, absent in 78 and there was disagreement in 31. Previous intervention was identified by both radiologists in a single case with no disagreement. The SAA was saccular in 130 cases and fusiform in 6 with 12 disagreements. These results are summarized in Table II.

With regards to aneurysm diameter the median diameter in each plane was remarkably similar at 14.71 mm for AP, 14.57 mm for transverse, and 14.38 mm for CC. The mean maximum diameter in any plane was 15.89 mm with a range of 7.5−62 mm.

A total of 113 SAAs (75.8%) had their maximal diameter in either the AP or transverse measurement. A further 34 SAAs (22.8%) had their axial maximum </ = 2.5 mm from the true maximum diameter. Only 2 SAAs (1.3%) had a maximum diameter >2.5 mm different from their largest axial measurement, at 4 mm and 4.5 mm. These results are summarized in Table III.

The most proximal normal SA diameter was identified by both observers in 146 cases, with a mean discrepancy of 1.28 mm and standard deviation (SD) of 1.21. The mean maximum SAA diameter to mean SA origin diameter ratio was 3.06 (1.4−11.4).

Interobserver Variability Between Radiologists

There was moderate concordance observed between the radiologists in identifying the presence of SAA with a Kappa value of 0.563.

The absolute mean difference in size between the radiologist measurements in all 3 planes and for maximum diameter in any plane remained consistent at around 2 mm with average SD between 1.35 and 1.52 mm. There was statistically significant agreement ($P < 0.05$) amongst the radiologists in SAA measurements in all 3 planes, with correlation coefficients of $r = 0.89$, $r = 0.90$ and $r = 0.91$ for the coronal, axial, and sagittal planes, respectively (Fig. 1). There were only 2 cases with a discrepancy of over 5 mm in maximal diameter between the 2 radiologists, details can be found in Table IV.

TABLE III. Aneurysm measurements

Measurement	Mean diameter (mm)	SD (mm)	Range (mm)
Anteroposterior	14.71	6.95	6.5−58.5
Transverse	14.57	7.19	6−62
Cranio-caudal	14.38	6.43	5.5−54.5
Maximum in any plane	15.89	7.35	7.5−62
Normal proximal SA	5.29	1.19	2.5−9.5

SA, splenic artery.

There was very good agreement in identifying calcification, yielding a Kappa value of 0.827 and moderate agreement in identifying the circumferential percentage of calcification with a Kappa value of 0.563. There was only moderate agreement in assessment of SAA morphology and presence of thrombus with Kappa values of 0.426 and 0.516, respectively.

The presence of contrast improved agreement in identifying thrombus with a Kappa statistic of 0.57 ($P < 0.05$) compared to 0.087 in the noncontrast studies ($P = 0.71$).

Three SAA features were rare, greatly reducing the interpretability of Kappa agreement analysis. The Kappa value for identifying rupture was 0 ($P = 1$) and 0.007 ($P = 0.9$) for identifying pseudoaneuryms. Both radiologists identified one case with prior intervention resulting in a Kappa value of 1 ($P < 0.05$). These results are summarized in Table V.

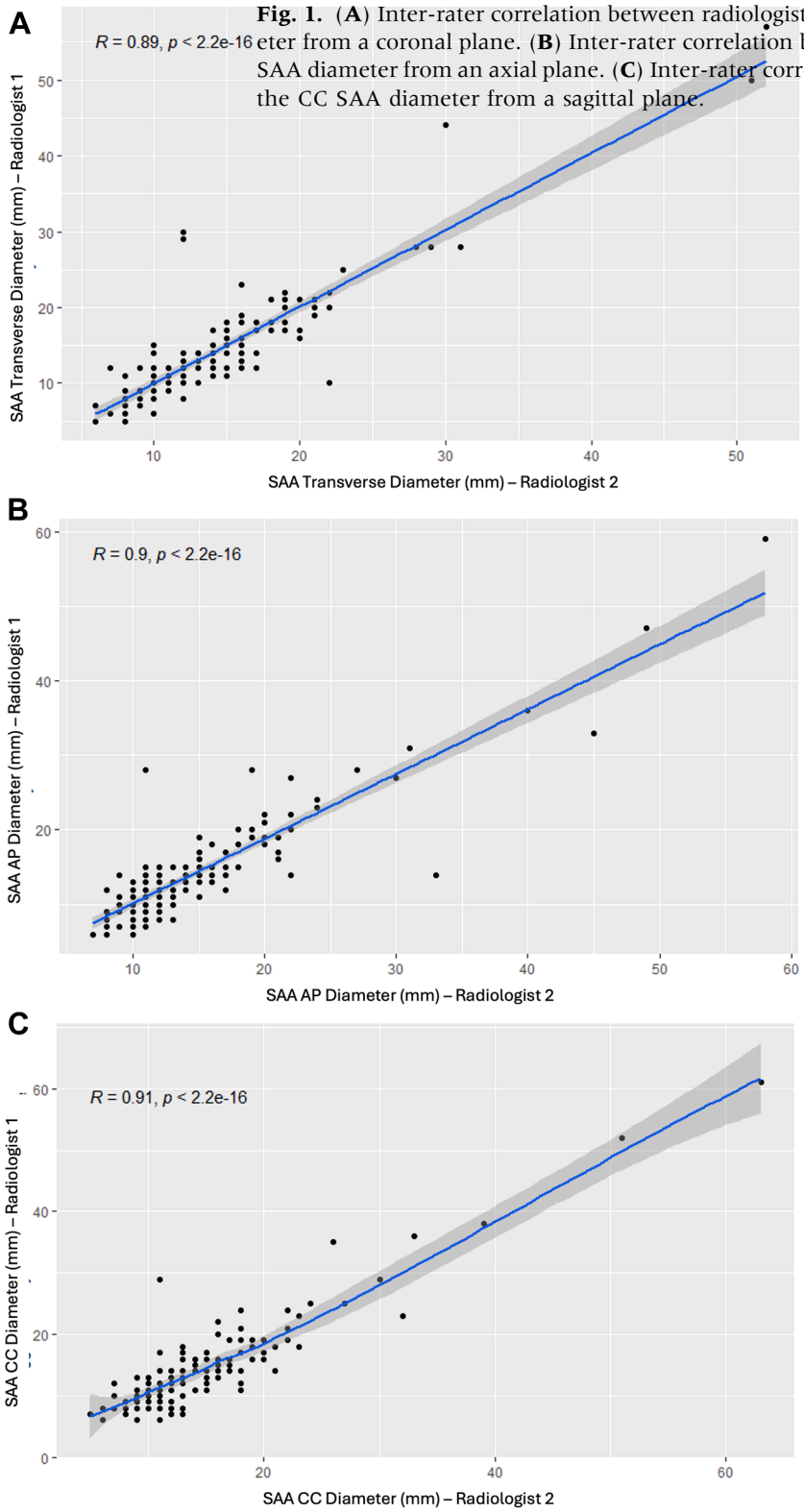

Fig. 1. (**A**) Inter-rater correlation between radiologists on assessing the transverse SAA diameter from a coronal plane. (**B**) Inter-rater correlation between radiologists on assessing the AP SAA diameter from an axial plane. (**C**) Inter-rater correlation between radiologists on assessing the CC SAA diameter from a sagittal plane.

TABLE IV. Evaluation of high discrepancy cases (over 5 mm in maximal diameter)

Case number	Age and sex	Expert-expert discrepancy	Expert - nonexpert discrepancy	Contrast phase	Patient and scan factors
1	55 M	9	NA	Arterial	Concomitant celiac axis aneurysm
2	89 F	18	NA	Portal venous	Large upper pole left renal cyst
3	72 M	NA	SAA not identified	Portal venous	-
4	38 F	NA	SAA not identified	Arterial	-
5	66 F	NA	SAA not identified	Portal venous	-
6	59 M	NA	SAA not identified	Portal venous	-
7	60 M	NA	15	Triple	2nd small SAA, pHTN with splenic collaterals
8	52 M	NA	8	Arterial	pHTN with splenic collaterals
9	77 F	NA	9	Portal venous	Upper pole left renal cyst, paucity of intra-abdominal fat
10	98 M	NA	11	Portal venous	Movement artifact across SAA

F, female; M, male; NA, not applicable (<5 mm); pHTN, portal hypertension; SAA not identified, splenic artery aneurysm not identified by nonexpert assessor.

TABLE V. Kappa agreements for aneurysm characteristics

Characteristic	Radiologists Kappa agreement	*P* value	Nonexpert Kappa agreement	*P* value
Presence of SAA	0.563	<0.001	0.129	<0.01
Calcification	0.827	<0.001	0.178	<0.001
Circumferential % calcification	0.563	<0.001	0.167	<0.001
Morphology	0.446	<0.001	0.011	0.829
Presence of thrombus	0.516	<0.001	0.184	<0.001
Rupture	0[a]	1	NA	NA
Pseudoaneurysmal	0.007[a]	0.934	NA	NA
Previous intervention	1[a]	<0.001	NA	NA

NA, not assessed.
[a]</ = 2 cases in series − limiting interpretability of kappa analysis.

Interobserver Variability for a Nonexpert

Assessment of scans was then undertaken by a nonexpert yielding an axial mean of 13.31 mm (SD 1.36), sagittal mean of 13.02 mm (SD 1.36), and coronal mean of 13.38 mm (SD 1.31). There was significant correlation ($P < 0.05$) between the radiologists' and nonexpert's measurements in all 3 planes with correlation coefficients of $r = 0.90$, $r = 0.94$ and $r = 0.93$ for AP, CC, and transverse measurements, respectively (Fig. 2). There were 8 further cases with over 5 mm discrepancy in maximal diameter measurements between the radiologists and the nonexpert, details can be found in Table IV.

SAA characteristics were then assessed by the nonexpert. Comparison of these results with those of the radiologists led to reduced Kappa values, with poor agreement among the 3 raters: The Kappa value for SAA detection dropped to 0.129, calcification to 0.178, circumferential calcification percentage to 0.167, and thrombus detection to 0.184. Despite reduction these values retained statistical significance. The agreement regarding the morphology of SAAs became insignificant, with a Kappa value of 0.011 ($P = 0.83$). These results are summarized in Table V.

Subgroup analysis demonstrated that contrast improved agreement between the nonexperts and radiologists. There was good agreement in identifying calcification with a kappa statistic of 0.710, moderate agreement in SAA identification, calcification percentage, and thrombus detection with kappa values of 0.594, 0.538, and 0.487, respectively, and fair agreement in SAA morphology at 0.237 (all $P < 0.001$).

Analysis of Cases with Discrepancy

In total there were 10 cases with >5 mm of discrepancy between raters. Two of these were between

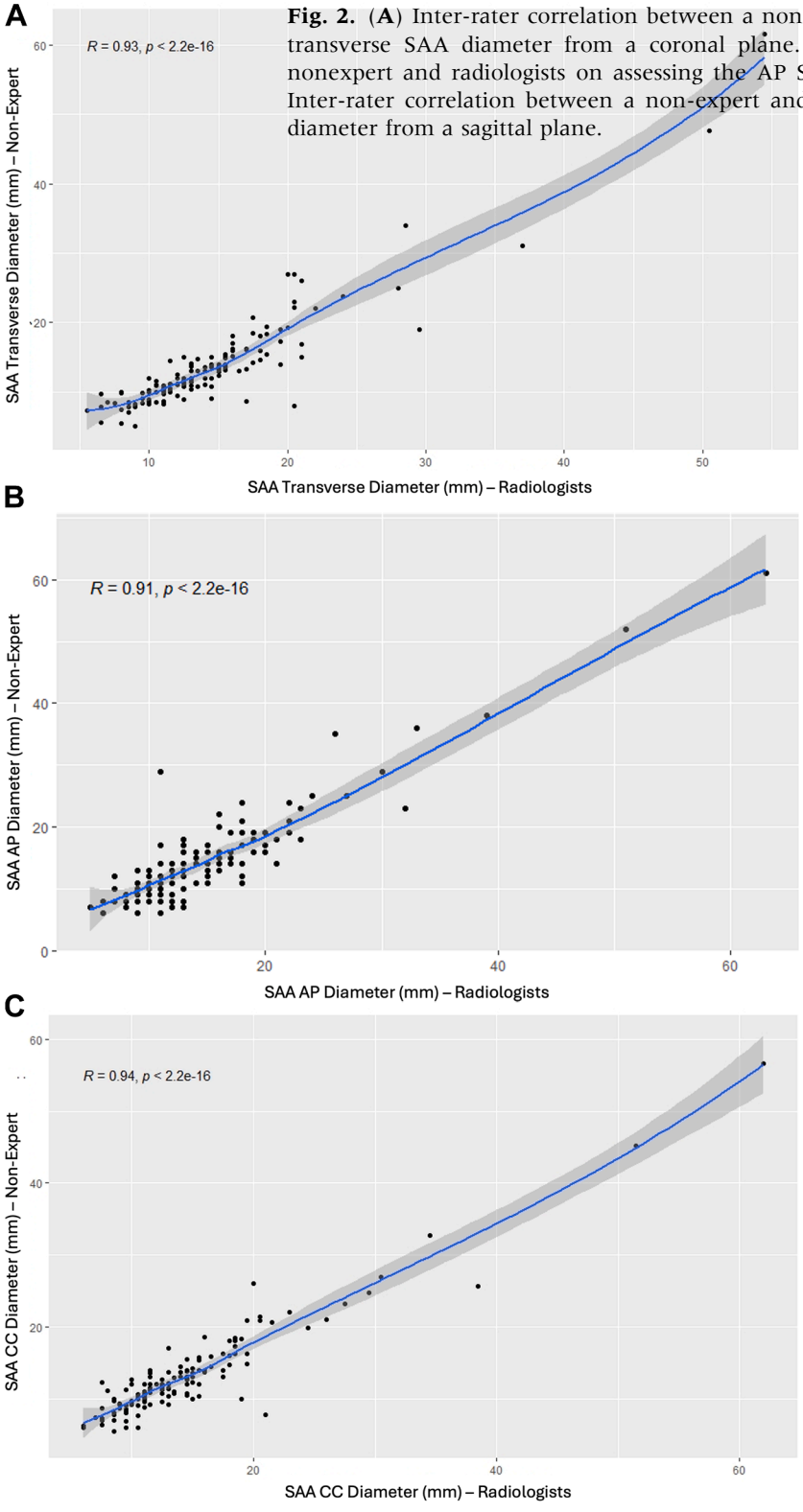

Fig. 2. (**A**) Inter-rater correlation between a nonexpert and radiologists on assessing the transverse SAA diameter from a coronal plane. (**B**) Inter-rater correlation between a nonexpert and radiologists on assessing the AP SAA diameter from an axial plane. (**C**) Inter-rater correlation between a non-expert and radiologists on assessing the CC SAA diameter from a sagittal plane.

experts (1.3% of cases), and 8 between the nonexpert and experts (5.4%). In 4 cases the nonexpert did not identify the SAA and in the other 6 cases there were patient and imaging factors which may have contributed to the discrepancy, case details are found in Table IV. The mean age of the patients in cases with discrepancy was slightly younger than the full cohort at 67 years, and 16.2% of male patients had a discrepant result compared to 3.6% of female patients, $P = 0.016$.

DISCUSSION

SAAs are the most common of the visceral aneurysms and having life-threatening consequences if they are missed and rupture. SAAs are increasingly commonly found incidentally on CT angiography and further reliable evidence is required to determine how this cohort of patients should be surveyed. From our study, even when being actively searched for, there are discrepancies in their identification by experienced radiologists highlighting the importance of increased awareness and protocolized assessment.

We have demonstrated that, despite their small size, SAAs can be reliably measured in all 3 anatomical planes by radiologists, with a marginal error of less than 1.52 mm, as indicated by the average SD. This is relatively reproducible by a nonexpert with similar standard deviations and a strong positive correlation with radiologist measurements. This would be an acceptable measurement discrepancy when treatment thresholds are based upon 5 mm scales of magnitude in the guidelines. There were only 2 cases (1.3%) with over a 5 mm discrepancy between radiologists in maximal SAA diameter, and a further 8 cases (5.4%) in which there was over 5 mm discrepancy between radiologists and the nonexpert assessor. In all these cases either the nonexpert could not identify the SAA or there was concomitant pathology or scan artifact making interpretation challenging, which in real-world practice should trigger further review in a vascular/radiology multidisciplinary meeting.

Another key finding is the relationship between maximum diameter measurable from an axial slice and the maximal SAA diameter when assessed in 3 planar MPR. We found over 75% of SAAs had their maximal diameter measurable within an axial slice (AP or transverse), and 99% of SAAs could be measured to within 2.5 mm of their maximal diameter via axially viewed imaging alone. This suggests that whilst 3 planar MPR assessments of SAAs remain the gold standard, taking the maximal diameter in an axial plane is an acceptable alternative, reducing the time required to evaluate imaging for patients in surveillance.

Additional to diameter, other key features could be reliably assessed by radiologists. Good agreement was achievable between radiologists for the presence of calcification and previous intervention. However, only moderate agreement was achieved for SAA identification, degree of calcification, presence of thrombus and morphology. This lower reliability should be taken into consideration when assessing SAAs in both research and clinical setting and management decisions should not be based on these characteristics alone. The presence of intravascular contrast improved the assessment of SAA thrombus and should therefore be utilized wherever feasible. Pseudoaneurysm morphology and rupture were less reliably identified by radiologists. These are rare phenomenon, and their suspicion is often based upon key clinical details, which were not available to the assessing radiologists in this study.

Our study suggests that a nonexpert can achieve significant correlation compared to radiologists in SAA measurement but is less comparable when assessing for aneurysm characteristics. Initial assessment of SAA should therefore be performed by a radiologist, but surveillance for aneurysm growth should be achievable by vascular surgeons, who are experts in the disease but not necessarily its imaging, in centers utilizing this approach.

There are several limitations inherent in the design of this study. Only 3 individual raters were used and whether these results are generalizable to other centers, including nonspecialist units, is unclear. Blinding of the raters was not complete, as due to the use of PACS the text report was also available to the assessors. The possibility of unblinding cannot therefore be ruled out. Additionally, these were not all dedicated scans to assess SAA, with a variety of contrast phases, image definition and movement artifact affecting image interpretation. Although this may have affected the accuracy of image assessment, this would have been constant between assessors and reflects ''real world'' constraints inherent in evaluating SAAs. The SAA identification Kappa statistic in our study is not generalizable due to the selection bias introduced by our search strategy limiting scans to only those in which an SAA had already been reported. Finally, our study was limited to those SAAs surveilled with CT, whether these findings are consistent with other SAA imaging techniques such are magnetic resonance, ultrasound or digital subtraction angiography remains uncertain.

CONCLUSION

Aneurysm diameter, previous intervention and calcification are the only 3 features which can be reliably and accurately assessed in SAAs. Presence of thrombus, degree of calcification and SAA morphology achieved only moderate agreement between observers and should be interpreted cautiously in both clinical and research settings.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Robert J. Leatherby: Writing — review & editing, Writing — original draft, Methodology, Investigation, Formal analysis, Data curation. **ChunHei Li:** Writing — review & editing, Methodology, Investigation, Formal analysis, Data curation. **Adelola Oseni:** Writing — review & editing, Data curation. **Rose Howroyd:** Writing — review & editing, Data curation. **James Budge:** Writing — review & editing, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Peter Holt:** Writing — review & editing, Supervision, Methodology, Conceptualization. **Iain Roy:** Writing — review & editing, Supervision, Project administration, Formal analysis, Conceptualization.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.avsg.2025.07.040.

REFERENCES

1. Horton KM, Smith C, Fishman EK. MDCT and 3D CT angiography of splanchnic artery aneurysms. Am J Roentgenol 2007;189:641—7.
2. Lee PC, Rhee RY, Gordon RY, et al. Management of splenic artery aneurysms: the significance of portal and essential hypertension. J Am Coll Surg 1999;189:483—90.
3. Björck M, Koelemay M, Acosta S, et al. Editor's choice — management of the diseases of mesenteric arteries and Veins: clinical practice guidelines of the european society of vascular surgery (ESVS). Eur J Vasc Endovasc Surg 2017;53:460—510.
4. Chaer RA, Abularrage CJ, Coleman DM, et al. The society for vascular surgery clinical practice guidelines on the management of visceral aneurysms. J Vasc Surg 2020;72:3S—39S.
5. Khairallah MK, Morgan RA, Das R. Technical considerations of endovascular management of true visceral artery aneurysms. CVIR Endovasc 2023;6:31.
6. Belli AM, Markose G, Morgan R. The role of interventional radiology in the management of abdominal visceral artery aneurysms. Cardiovasc Intervent Radiol 2012;35:234—43.
7. Wang S, Huang W, Liu J, et al. Selection of endovascular treatment strategies and analysis of the efficacy of different locations and types of splenic artery aneurysms. CVIR Endovasc 2024;7:1—10.
8. An TJ, Chen X, Omar OMF, et al. The natural history of splenic artery aneurysms: factors that predict aneurysm growth. J Vasc Interv Radiol 2024;35:972—8.
9. Shang EK, Nathan DP, Boonn WW, et al. A modern experience with saccular aortic aneurysms. J Vasc Surg 2013;57:84—8.
10. Zhang J, Ratner M, Harish KB, et al. The natural history and long-term follow-up of splenic artery aneurysms. J Vasc Surg 2024;79:801—807.e3.
11. Ghatwary T, Karthikesalingam A, Patterson B, et al. St George's vascular institute protocol: an accurate and reproducible methodology to enable comprehensive characterization of infrarenal abdominal aortic aneurysm morphology in clinical and research applications. J Endovasc Ther 2012;19:400—14.
12. Lombardi JV, Hughes GC, Appoo JJ, et al. Society for vascular surgery (SVS) and society of thoracic surgeons (STS) reporting standards for type B aortic dissections. J Vasc Surg 2020;71:723—47.
13. Wickham H. Stringr: simple, consistent wrappers for common string operations 2023. Available at: https://github.com/tidyverse/stringr. Accessed December 31, 2024 https://stringr.tidyverse.org.
14. R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing, 2021.