SA-CME

Managing Incidental Findings on Abdominal and Pelvic CT and MRI, Part 2: White Paper of the ACR Incidental Findings Committee II on Vascular Findings

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This white paper describes vascular incidental findings found on CT and MRI of the abdomen and pelvis. Recommendations for management are included. This represents the second of 4 such papers from the ACR Incidental Findings Committee II, which used a consensus method based on repeated reviews and revisions and a collective review and interpretation of relevant literature. Topics include definitions and recommended management for abdominal aortic, iliac, splenic, renal, and visceral artery aneurysms. Other incidentally discovered aortic conditions, systemic venous anomalies, compression syndromes, abdominal venous thrombosis, and gonadal and pelvic venous conditions are also discussed. A table is provided for reference.

Key Words: Incidental findings, incidentaloma, ACR, consensus, CT, MRI, aneurysm

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FOREWORD

This white paper does not comprehensively review the interpretation and management of vascular abnormalities but provides general guidance for managing common, incidental vascular findings on CT and MRI, appreciating that individual care will vary depending on each patient's specific circumstances, the clinical environment, available resources, and the judgment of practitioners. Also, the term *guidelines* is not used in this or prior white papers to avoid the implication that these represent components of the ACR Practice Guidelines and Technical Standards (which represent official ACR policy, having undergone a rigorous drafting and review process culminating in approval by the ACR Council) or the ACR Appropriateness Criteria® (which use a formal consensus-building approach using a modified Delphi technique). This white paper, which represents the collective experience of the members of the ACR Incidental Findings Committee II, was developed through a less formal process of repeated reviews and revisions of the draft document and does not represent official ACR policy. For these reasons, this white paper should not be used to establish the legal standard of care in any particular situation.

INTRODUCTION

Please refer to the overview of the work of the Incidental Findings Committee II [1] for a description of the purposes, structure and process, and conventions used in these 4 white papers, of which this is the second. The authors of this white paper represent the Vascular Subcommittee membership, as listed in the appendix. The roster of the entire Incidental Findings Committee II is listed in the appendix of the overview of this project [1].

INCIDENTAL VASCULAR FINDINGS

This section describes the committee's consensus on nomenclature and recommendations for managing and fol-

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lowing up the most common and important types of incidental vascular findings seen on CT and MRI of the abdomen and pelvis.

Abdominal Aortic Aneurysm (AAA)

AAA represents a progressive increase in the aortic luminal diameter and is the 10th most common cause of death in the Western world [2]. AAA is usually described by its relationship to renal arteries (ie, suprarenal or infrarenal). The normal diameter of the suprarenal abdominal aorta is up to 3.0 cm, and that of the infrarenal abdominal aorta is 2.0 cm. Aneurysmal dilation of the infrarenal aorta is defined as a diameter ≥3.0 cm or dilation of the aorta ≥1.5 times the normal diameter [3]; on the basis of these criteria, 9% of people aged >65 years have an AAA [4].

Multiple causes may contribute to the development and progression of aortic aneurysms, including smoking, male gender, age at detection, diabetes, hypertension, and hypercholesterolemia [5,6]. There is also a strong association between initial size and the subsequent rate of growth of an AAA. Therefore, we recommend tailoring follow-up intervals according to the size of the AAA at the time of detection, especially when previous growth patterns are unknown [7,8]. Emergency surgery for aortic aneurysm rupture is associated with 46% mortality (as opposed to 4%-6% for elective repair), and rupture occurs with increasing frequency as the aneurysm size exceeds 5 cm [9]. It is therefore valuable to detect AAAs and follow up until elective repair is indicated [10].

Detection and Characterization. An AAA may be encountered as an incidental finding on ultrasound, CT, or MRI. Ultrasound can detect and size AAAs, with the advantages of being relatively inexpensive and noninvasive and not requiring the use of intravenous contrast material. The limitations are that overlying bowel gas can obscure findings, and ultrasound is operator dependent. CT and MRI can define the extent and size of an aneurysm, depict intraluminal thrombus, and show the involvement and relationship of branch vessels, allowing the correct choice of therapy. Optimizing follow-up imaging intervals can help balance safety, cost, and patient anxiety. For abdominal aortic diameters <2.5 cm, follow-up is generally thought to be unnecessary. Because the rupture of smaller AAAs is less likely [10], and a recent meta-analysis [11] suggested that less frequent follow-up on smaller aneurysms in male patients may be equally safe, we recommend longer intervals between follow-up examinations. The follow-up intervals for imaging may also vary depending on comorbidities and the growth rate of the aneurysm [12]. Our recommendations, listed in Table 1, are based on published literature [7,13,14] and the consensus opinion of the committee.

Table 1. Recommended intervals for initial follow-up imaging of ectatic aortas and abdominal aortic aneurysms

Aortic Diameter (mm)	Imaging Interval
2.5-2.9	5 y
3.0-3.4	3 y
3.5-3.9	2 y
4.0-4.4	1 y
4.5-4.9	6 mo*
5.0-5.5	3-6 mo*

Note: For abdominal aortic diameters <2.5 cm, follow-up is generally thought to be unnecessary. Because the rupture of smaller abdominal aortic aneurysms is less likely, we recommend longer intervals between follow-up examinations. Follow-up intervals may vary depending on comorbidities and the growth rate of the aneurysm.
*In addition to planning follow-up imaging, one should also consider surgical or endovascular referral.

Penetrating Aortic Ulcer (PAU)

Penetrating aortic ulcers (PAUs) represent disruption of atherosclerotic plaque with penetration of luminal blood for variable distances into or through the aortic wall. They may present with acute symptoms and findings, but they may also be recognized as chronic, asymptomatic, incidental findings. A PAU may progress to an intramural hematoma, a focal dissection, or a pseudoaneurysm and rupture, or it may completely resolve [15]. It is typically seen in elderly patients with atherosclerosis, and because the symptoms of a rupturing PAU may be insidious, it may be difficult to determine by imaging alone if it is causing a patient's symptoms or is incidental. It also may be difficult to differentiate PAU from asymptomatic aortic conditions such as saccular pseudoaneurysms and true aneurysms on the basis of imaging alone. Studies have shown that the natural history of PAU is variable, unpredictable, and may be one of progressive enlargement resulting in rupture. Because the lack of symptoms does not necessarily imply stability, we recommend annual follow-up when asymptomatic and more frequent follow-up if symptoms arise [16], with consideration of surgical or endovascular intervention.

Dissections and intramural hematomas are almost always symptomatic and, therefore, are not usually incidental findings and are not further discussed in this white paper.

Iliac Artery Aneurysm

Aneurysms involve common and internal iliac arteries more commonly than external iliac arteries. Iliac artery aneurysm is defined as a vessel diameter ≥1.5 times the normal iliac artery diameter or ≥2.5 cm in diameter. Iliac artery aneurysms are rare in isolation; Lawrence et al [17] reported a prevalence of 6.58 per 100,000 hospitalized men and 0.26 per 100,000 hospitalized women in the United States. Aneurysms that are <3.0 cm in diameter tend to be asymptomatic, rarely rupture, and expand slowly; those that are 3.0 to 3.5 cm should be followed up with cross-sectional imaging initially at about 6 months. If stable, repeat scan-

ning can be performed annually. Iliac artery aneurysms >3.5 cm have a greater tendency to rupture and should be followed more closely or treated expeditiously [18].

Splenic Artery Aneurysm

Splenic artery aneurysms are the most common visceral aneurysms and the third most common intra-abdominal aneurysm, after those occurring in the aorta and iliac arteries [19-21]. In a series of >300 visceral artery aneurysms, 70.9% were of the splenic artery [20]. The vast majority are true aneurysms, although pseudoaneurysms related to prior inflammation, especially pancreatitis, or infection may occur [21]. The estimates of prevalence of splenic artery aneurysms vary, but a retrospective review of nonselective angiograms suggests that an incidence estimate of 0.8% may be the most accurate [21].

Risk factors for developing these aneurysms are similar to those for other aneurysms. In a review of the clinical features of 217 patients with splenic artery aneurysms, hypertension was present in 50.2%, obesity in 27.6%, coronary artery disease in 23.5%, and hypercholesterolemia in 21.7% [20]. Splenic artery aneurysms occur more frequently in women [21]. As mentioned previously, pseudoaneurysms of the splenic artery are rare [19]. In a series of 128 patients from the Cleveland Clinic with splenic artery aneurysms, only 6 (4.7%) were believed to be pseudoaneurysms, with 5 of these occurring in the setting of acute or chronic pancreatitis [21]. Most splenic artery aneurysms are incidentally detected during cross-sectional imaging [20,21] and it is difficult to confidently attribute abdominal symptoms to such aneurysms.

Spontaneous rupture of a splenic artery aneurysm is rare, especially for smaller (<2 cm) aneurysms [20], but may occur, usually with larger aneurysms. Additional risk factors associated with rupture include rapidly increasing size, occurrence in women of childbearing years, cirrhosis (especially associated with α_1 antitrypsin deficiency), and symptoms that can be attributable to the aneurysm [19-21].

The surgical literature suggests a consensus that such an aneurysm should be considered for endovascular therapy when ≥2 cm [20,21]. Smaller aneurysms probably can be safely followed, although the clinical risk factors for rupture should be carefully assessed. In one review of patients who were followed with small splenic artery aneurysms, the mean aneurysm growth rate was 0.06 cm/y, with the most rapid growth rate noted to be 1 cm over 63 months [20]. In this group of patients, none of the aneurysms ruptured [20]. Given these data, yearly surveillance for small splenic artery aneurysms is recommended, although for the smaller aneurysms among those ≥2 cm, surveillance intervals of >1 year may be reasonable, depending on comorbidities and life expectancy.

Renal Artery Aneurysm (RAA)

RAA is uncommon, occurring in about 0.09% of the population [22,23]. Etiologies include fibromuscular dysplasia (FMD), atherosclerosis, and pseudoaneurysms that may occur after trauma [23]. In a review of 168 patients with 252 RAAs, 34% had FMD, 25% had atherosclerosis, 6.5% had concurrent aneurysms of other vessels, and 73% had hypertension [22]. RAAs are usually detected incidentally at cross-sectional imaging [23], are small, are asymptomatic, and have uncertain clinical relevance [22]. However, they may rupture, especially if they enlarge, and may be associated with renal arterial hypertension [22,23].

RAAs related to FMD should be considered when there is a classic "string of beads" appearance to the renal artery or when aneurysms occur in younger women, especially when associated with hypertension [22]. Pseudoaneurysms typically occur after trauma and are usually located within the parenchyma of the kidney [22,23]. Other aneurysms, not related to FMD or trauma, typically occur at branch points in the renal artery.

The decision to treat or repair an RAA should be based on factors including patient age and gender and anatomic features of the aneurysm, including size [22]. One approach that has been suggested is to repair all aneurysms ≥1 cm in patients with uncontrolled hypertension [22]. An incidentally discovered RAA measuring 1.0 to 1.5 cm can be safely followed [22,23]. In a series of 86 RAAs with a mean size of 1.3 cm, none ruptured after an average follow-up of 72 months [22]. We recommend that a reasonable imaging follow-up interval in these asymptomatic individuals is every 1 to 2 years. Larger aneurysms, measuring >1.5 to 2.0 cm, should be considered for surgical or endovascular repair [22].

Other Visceral Artery Findings

Outside of the splenic and renal circulations, visceral aneurysms can affect the celiac, hepatic, gastroduodenal, pancreaticoduodenal, gastric, or mesenteric arteries. After splenic and renal arterial aneurysms, the hepatic artery is the next most common location [24]. When discovered incidentally, these aneurysms are typically caused by atherosclerosis and may be associated with aneurysmal disease elsewhere [25]. They can also be mycotic, traumatic (including iatrogenic trauma for hepatic aneurysms after liver biopsy), or, less commonly, related to polyarteritis nodosa, FMD, or visceral inflammatory disease, such as pancreatitis [25,26]. As with all aneurysms, rupture is the feared risk and is the reason for considering surgical or endovascular treatment.

Treatment is generally recommended for aneurysms >2 cm in diameter, possibly with a smaller threshold for nonatherosclerotic aneurysms [27,28]. For hepatic aneurysms, Abbas et al [29] established that multiplicity and nonatherosclerotic origin were linked to increased rupture rate. Criteria for which it is safe to observe visceral arterial aneurysms have not been clearly established. In the study of Abbas et al, of 21 patients with a mean follow-up interval of 68.4 months and mean diameter of 2.3 cm, none required intervention during the follow-up period.

However, pancreaticoduodenal aneurysms are felt to be at higher risk for rupture, and some authors recom-

mend that all of these aneurysms undergo surgical or endovascular treatment, regardless of size [30,31]. If a decision is made to observe rather than treat, repeat scanning at annual intervals is recommended to assess for interval growth. Initial scanning could be at a shorter interval, especially if pseudoaneurysm is a consideration.

Isolated visceral arterial dissection, typically of the superior mesenteric artery, can occasionally be seen as an incidental finding. Cho et al [32] published a study of 30 patients, 13 of whom were asymptomatic and 25 of whom were treated conservatively without surgical or percutaneous intervention. In the 15 patients followed with CT for a mean of 15.6 months, none progressed, 7 showed no change, 4 improved, and 4 completely resolved. The researchers concluded that follow-up imaging, rather than prompt treatment, is appropriate for asymptomatic dissection.

The arcuate ligament can occasionally compress the celiac axis origin; this is demonstrable on cross-sectional imaging performed at end-expiration [33]. When noted incidentally in a patient without relevant symptoms, no further action is necessary. The celiac, superior, and inferior mesenteric artery origins are frequently affected by atherosclerotic stenosis. As long as this remains well compensated by collateral vessels and is not symptomatic with postprandial abdominal pain or weight loss, no further evaluation or follow-up is recommended.

Systemic Venous Anomalies and Compression Syndromes

A variety of congenital anomalies and pathologic conditions can affect the inferior vena cava (IVC) and branch vessels, including caval duplication, left-sided IVC, azygous continuation of the IVC and retroaortic or circumaortic renal veins [34]. Most congenital anomalies are asymptomatic, but familiarity with their appearance helps avoid misinterpreting them as abnormal findings. Awareness of vascular anatomic variants becomes important when an asymptomatic patient volunteers to donate a kidney or a liver segment or if an interventional or vascular procedure is planned.

The size and shape of the IVC can vary with respiration, volume status, and cardiac output. A "flat" IVC, when associated with other CT abnormalities, may be caused by volume depletion or shock but can also be seen as a normal variant [35]. Dilation or reflux opacification of the intrahepatic IVC or hepatic veins has been associated with cardiac disease but the latter can also be seen in normal patients undergoing CT with high injection rates (>3 mL/s) [36]. The most common IVC filling defect seen on CT is pseudothrombosis caused by laminar flow of enhanced blood from the renal veins streaming parallel to the column of unopacified blood returning from the lower body [37]. Similar artifactual filling defects in other vessels may also result from mixing of enhanced and unenhanced blood or from laminar reflux of opacified blood from the heart into the IVC. Delayed CT, ultrasound, or MR venography can be performed for indeterminate cases [38].

Compression of the left common iliac vein by the anteriorly crossing right common iliac artery, known as May-Thurner or iliocaval compression syndrome, may be associated with left lower-extremity venous hypertension, edema, and venous thrombosis (VT). However, both cadaveric and retrospective CT studies from asymptomatic patients [39] suggest that this anatomic variant is present in approximately 25% of the population, indicating that most patients with compression are not symptomatic [40], and follow-up is not necessary unless the patient develops unilateral symptoms of leg swelling or VT. Similarly, compression of the left renal vein between the aorta and superior mesenteric artery with localized varices, known as the nutcracker syndrome, is an occasional asymptomatic incidental finding. If the patient is not hypertensive and does not have proteinuria or hematuria, this anatomic finding is likely clinically unimportant.

Incidental Abdominal VT

VT has many causes, including hypercoaguable states, portal hypertension, vessel wall damage, and cancer. Imaging signs of VT may be direct or indirect, with imaging often helping differentiate between acute and chronic thrombi and between bland and tumor thrombi [38,41]. In a recent retrospective study of 2,619 consecutive abdominal CT examinations performed in a nonselected patient population, the prevalence of VT was 1.74% [42]. In the same study, when patients with malignancy and cirrhosis were excluded, the prevalence decreased to 0.36%. However, these data are from a single retrospective study in which pelvic veins were not evaluated, so these results may not be generalizable.

How to further evaluate VT depends on location and the local availability and expertise for particular techniques. Peripheral and superficial VT is usually best studied with ultrasound; for intracranial, intrathoracic, or abdominopelvic VT, CT or MRI may be the preferred modality. Nuclear medicine flow studies have essentially been replaced by cross-sectional imaging. Once VT is diagnosed as chronic (small vein, wall thickening, extensive collateral vessels, absence of intraluminal filling defects other than webs), usually no follow-up imaging is recommended.

Gonadal and Pelvic Veins

Ovarian veins originate from the plexus in the broad ligament near the ovary and fallopian tubes and communicate with the uterine plexus, then course anterior to the psoas muscle and the ureter [43]. The right ovarian vein typically drains into the IVC and the left ovarian vein into the left renal vein. Autopsy studies have shown that valves are absent in the cranial portion of the ovarian vein in 15% of women on the left and 6% on the right [44]. The valves are incompetent on either side in 35% to 43%, with a higher frequency in multiparous women, resulting in dilation >8 mm and incompetence in many asymptomatic patients

who undergo CT [45]. Anatomic differences of the ovarian veins cannot solely explain different rates of reflux between the right and left systems, but the decreased diameter of the left renal vein at the aortomesenteric portion likely contributes to this finding [46], similar to the nutcracker syndrome described above.

Incompetence of the ovarian and draining pelvic veins and venous reflux are considered the main cause of pelvic congestion syndrome in women, symptoms of which include persistent dull pelvic pain lasting >6 months, dysmenorrhea, dyspareunia, postcoital ache, and urinary symptoms. However, dilated pelvic veins are often seen incidentally in asymptomatic multiparous women [46]. If dilated pelvic veins are noted in a woman and are asymptomatic, no further imaging or intervention is recommended. In a CT angiographic study of potential renal donors, dilated ovarian veins were found in 16 (47%) of 34 asymptomatic women [45]. In another CT study of patients with severe ovarian vein reflux, but without PCS, both right and left parauterine veins were tortuous and dilated in all cases, with a mean vein diameter of 5.9 ± 1.6 mm (range, 4.3-8.0 mm) [46]. Pelvic varices, and early opacification and dilation of the gonadal veins, may occur without venous reflux, particularly if uterine fibroids [47] or other pelvic abnormalities are present [48].

Gonadal vein thrombosis can be seen in up to 80% of asymptomatic women who undergo routine CT after hysterectomy and lymphadenectomy for neoplasm [49]. When acute, the central thrombus typically demonstrates low attenuation and is associated with mural enhancement. The vessel chronically becomes fibrotic and contracted, and phleboliths may develop [49].

TAKE-HOME POINTS

- The committee recommends follow-up imaging at decreasing intervals with increasing diameter for AAA (3 years for 3.0-3.4 cm, 2 years for 3.5-3.9 cm, 1 year for 4.0-4.4 cm, 6 months for 4.5-4.9 cm, and 3-6 months for 5.0-5.5 cm) and consideration of vascular or endoscopic referral for the larger AAAs in these ranges.
- Iliac artery aneurysms 3.0 to 3.5 cm in size should be followed up with cross-sectional imaging initially at about 6 months.
- The surgical literature suggests a consensus that RAAs should be considered for endovascular therapy when ≥2 cm, while smaller aneurysms probably can be safely followed.
- For visceral artery aneurysms, treatment is generally recommended for aneurysms >2 cm in diameter, possibly with a smaller threshold for nonatherosclerotic aneurysms.
- Pancreaticoduodenal aneurysms are felt to be at higher risk for rupture, and all of these aneurysms should be considered for surgical or endovascular treatment.
- Incompetence of the ovarian and draining pelvic veins and venous reflux are considered the main cause of pelvic congestion syndrome, symptoms of which include persistent dull pelvic pain lasting >6 months, dysmenorrhea, dyspareunia, postcoital ache, and urinary symptoms.

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APPENDIX

Committee Members

Incidental Findings Committee II: Lincoln L. Berland, MD (chair).

Vascular Subcommittee: Faisal Khosa, MD (chair), Glenn Krinsky, MD, Michael Macari, MD, E. Kent Yucel, MD.

Ex Officio: James A. Brink, MD (chair), ACR Body Imaging Commission.

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