

Role of Ultrasound in Diagnosing of Abdominal Aortic Aneurysm?

M Ayub Hussain*, Tenzin Dakpa, Mahrufa Fardous, Francy Melo, Francisca Martinez and Bozena Brzostowski

New York Medical Career Training Center, New York, USA

*Corresponding Author: M Ayub Hussain, Program Director at New York Medical Career Training Center, New York, USA.

Received: October 23, 2018; Published: November 30, 2018

Abstract

Abdominal Aortic Aneurysm (AAA) is a dilatation of the abdominal aortic artery. It is defined as an aortic diameter at least one and one-half times the normal diameter at the level of the renal arteries, which is approximately 2.0 cm. In general the dilated portion of the abdominal aorta with a diameter of greater than 3.0cm is considered an aortic aneurysm [1,2]. Approximately 80% of aortic aneurysms occur between the renal arteries and the aortic bifurcation. Aortic aneurysms constitute the 14th leading cause of death in the United States [3]. Each year in the United States, Abdominal Aortic Aneurysm (AAA) rupture causes 4,500 deaths, with an additional 1,400 deaths resulting from the 45,000 repair procedure performed to prevent rupture [4]. The risk of abdominal aortic aneurysms (AAAs) increases dramatically in the presence of the following factors: age older than 60 years, smoking, hypertension and caucasian ethnicity. The likelihood that an aneurysm will rupture is influenced by the aneurysm size, expansion rate, continued smoking and persistent hypertension. The majority of AAAs are asymptomatic and are detected as an incidental finding on ultrasonography, abdominal computed tomography or magnetic resonance imaging performed for other purposes. It can also present with abdominal pain or complications such as thrombosis, embolization and rupture. Approximately 30% of asymptomatic AAAs are discovered as a pulsatile abdominal mass on routine physical examination. Abdominal ultrasonography is considered the screening modality of choice for detecting AAAs because of its high sensitivity and specificity, as well as its safety and relatively lower cost.

Keywords: Abdominal Aortic Aneurysm; Endovascular Aneurysm Repair (EVAR); Endoleaks; Pseudoaneurysm

Introduction

The aorta is the largest artery in the body, it measures at approximately 1 inch (2.5 centimeters) in diameter. An aneurysm is an enlarged portion of a weak area of an artery. An abdominal aortic aneurysm (AAA) is an enlargement of a weak area of the main blood vessel (aorta) that carries blood away from the heart. Aneurysms represent a dilatation in all three layers of the vessel wall, AAA's develop after the degeneration of the tunica media. The degeneration ultimately leads to widening of the vessel lumen and loss of the structural integrity. Generally, a segment of abdominal aorta with a diameter of greater than 3.0 centimeters is considered an aortic aneurysm. Overtime, blood flow can cause the weak area to grow in diameter and enlarge. An aneurysm can grow to be more than 5.0 centimeters in diameter while showing no symptoms at all, known as asymptomatic. If the aneurysm grows to reach 5.5 centimeters in diameter, probability of rupture is most likely to occur. Larger aneurysms are more likely to rupture resulting in internal bleeding leading to death unless treated. Only about half of patients with a ruptured AAA who get medical treatment have a chance of survival. Approximately 80% of aortic aneurysms occur between the renal arteries and the aortic bifurcation. Consequences depend on the size, location and cause of the rupture. A large aneurysm rupture may be fatal, and a small aneurysm rupture may give a warning symptom such as extreme abdominal pain that allows the person to seek medical care. Even with medical treatment there are many high risks that occur during surgery associated with rupture. In the United States alone, Abdominal Aortic Aneurysm (AAA) rupture causes 4,500 deaths, with an additional 1,400 deaths resulting from the 45,000 repair procedure performed to prevent rupture [4]. The probability that an aneurysm will rupture is influenced by the aneurysm size, expansion rate, continued smoking and persistent hypertension [5-11].



Figure 1: A normal abdominal aorta will measure less than 2.5 cm. Borders can be seen clearly and hyperechoic with regular borders. Also see the Celiac Artery and SMA clearly.



Figure 2: An abnormal abdominal aorta will measure more than 3 cm.

Discussion

The risk of abdominal aortic aneurysm increases with an individual’s history of hypertension, cardiac or renal transplant, smoking, pathogens, family history as well as epidemiology which will be discussed. AAAs are more likely to occur if you are male over the age of 60, Caucasian, obese or overweight, have a family history of heart conditions and diseases, high blood pressure, high cholesterol or fatty buildup in the blood vessels (atherosclerosis), have had trauma to your abdomen or midsection and smoke tobacco products. Mycotic aneurysms are rare and their prognosis is asymptomatic. Mycotic aneurysms of the aorta may result from various infectious organisms or can be a suitable environment for many infectious agents [13]. The most common isolated pathogens from infected aortic aneurysms are Salmonella and Staphylococcus [12]. This condition lowers the body’s immune system causing higher risk for developing an abdominal aortic aneurysm. The survival after mycotic aneurysms is very low when compared to atherosclerotic aneurysms, reaching only to 50% at 5 years [14]. There is no way to foresee an abdominal aortic aneurysm but there may be ways to lower your risk, simply by leading a healthy lifestyle, eating right, exercising, not smoking tobacco, taking proper medication to reduce hypertension, and visiting your doctor for routine visits. Although AAA’s grow slowly and are usually asymptomatic unless they rupture there may be a few indicators for concern.

Some symptoms that are associated with abdominal aortic aneurysm may include having clammy and sweaty skin, lightheadedness, pain in the back, belly or side areas, nausea, vomiting, constipation and dysuria may be signs of an impending rupture. As the aneurysm grows, some people may notice a pulsating feeling around the navel and may also discover a palpable mass in the abdominal area. If an abdominal aortic aneurysm is suspected, it should be diagnosed for further observance or repair. AAA is usually diagnosed by anatomical imaging techniques such as Ultrasound, MRI and/or CT. In comparison with other anatomical imaging techniques ultrasonography is non-invasive, quick, inexpensive, quite accurate, all of which are ideal features for routine screening. Because of its effective results, ultrasonography is the standard method for screening and monitoring AAAs that have not ruptured [5]. In the case of an emergency, bed-side ultrasound examination could act as an extension of routine ultrasound for specific symptoms. In addition, intravascular ultrasound is another tool that can be applied for endovascular management of AAA, such as confirming the AAA size measured in a routine abdominal CT scan [6]. After diagnosis of an abdominal aortic aneurysm, your doctor may make a recommendation for open repair or endovascular aneurysm repair (EVAR). Two methods of repair currently available for an abdominal aortic aneurysm are open repair and endovascular aneurysm repair (EVAR). In Open Repair surgery, the doctor makes a large incision in the abdomen to expose the aorta and visualize the aneurysm. A cylinder-like tube called a graft is sewn into the aorta, connecting one end of the aorta at the site of the aneurysm to the other end of the aorta. Some advantages are that it excludes the aneurysm and prevents recurrent aneurysms, there is 40 years clinical experience using this procedure and reduced risk of rupture. Disadvantages are that it is a risky procedure with a lengthy recovery time, myocardial infarction (heart attack), bleeding during or after surgery, limb ischemia (loss of blood flow to the legs and feet), embolus (clot) to other parts of the body, lung problems, kidney damage, and spinal cord injury.

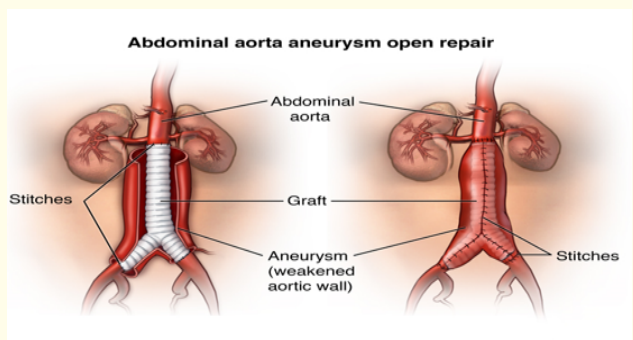


Figure 3: AAA Open Repair.

Endovascular aneurysm repair (EVAR) is a minimally invasive, which means it is done without a large incision, only a small incision is made in the groin area. The surgeon first inserts a catheter into an artery in the groin (upper thigh) and threads it to the aneurysm. Then, using an ultrasound machine to see the artery, the surgeon threads the graft (also called a stent graft) into the aorta to the aneurysm. The graft is then expanded inside the aorta and fastened in place to form a stable channel for blood flow. The graft reinforces the weakened section of the aorta to prevent the aneurysm from rupturing. The advantages of (EVAR) include being minimally invasive, fast procedure with shorter recovery time, and reduced risk of death. Disadvantages include infection complications, kidney damage, bleeding, ischemic complications, local wound complications, access artery injury and spinal cord injury. With the EVAR procedure, post grafting of the abdominal aortic aneurysm carries a risk of developing a complication named endoleak.

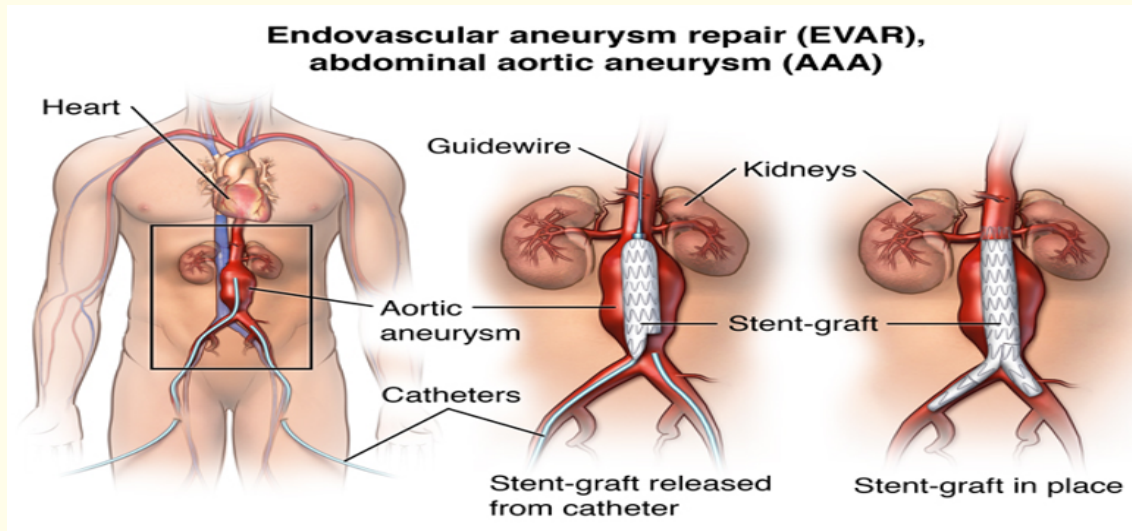


Figure 4: Endovascular aneurysm repair.

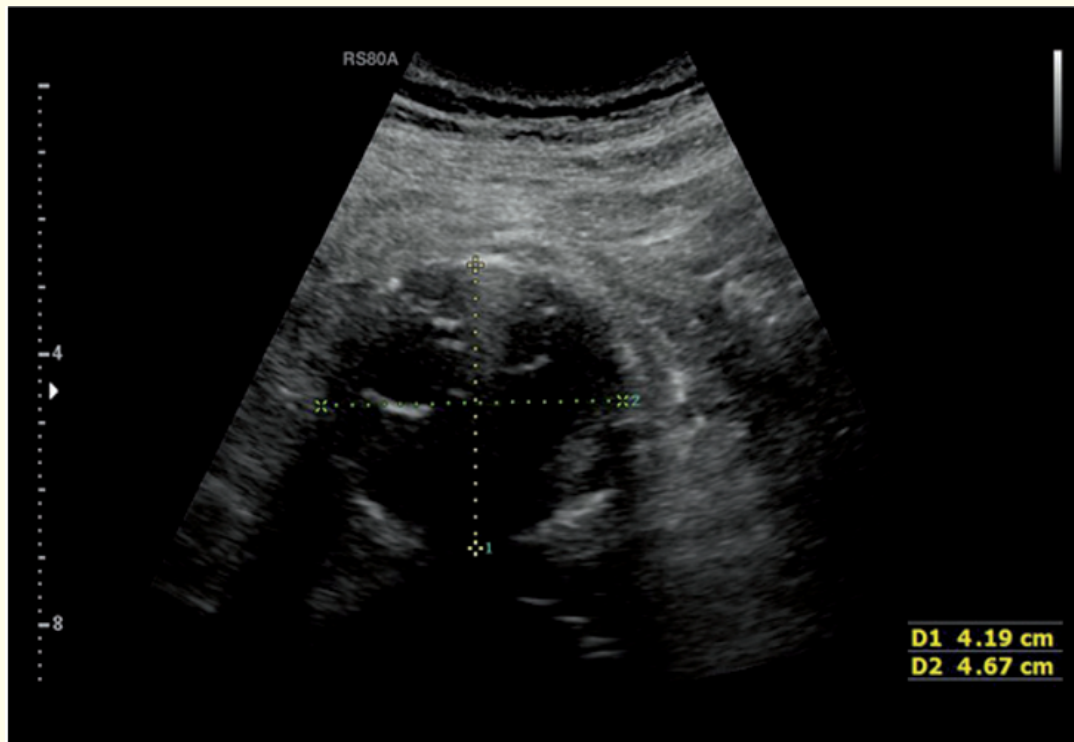


Figure 5: Initial B mode ultrasound in a patient after EVAR showing the endoluminal stents inside the partly thrombotic aneurysm sac.

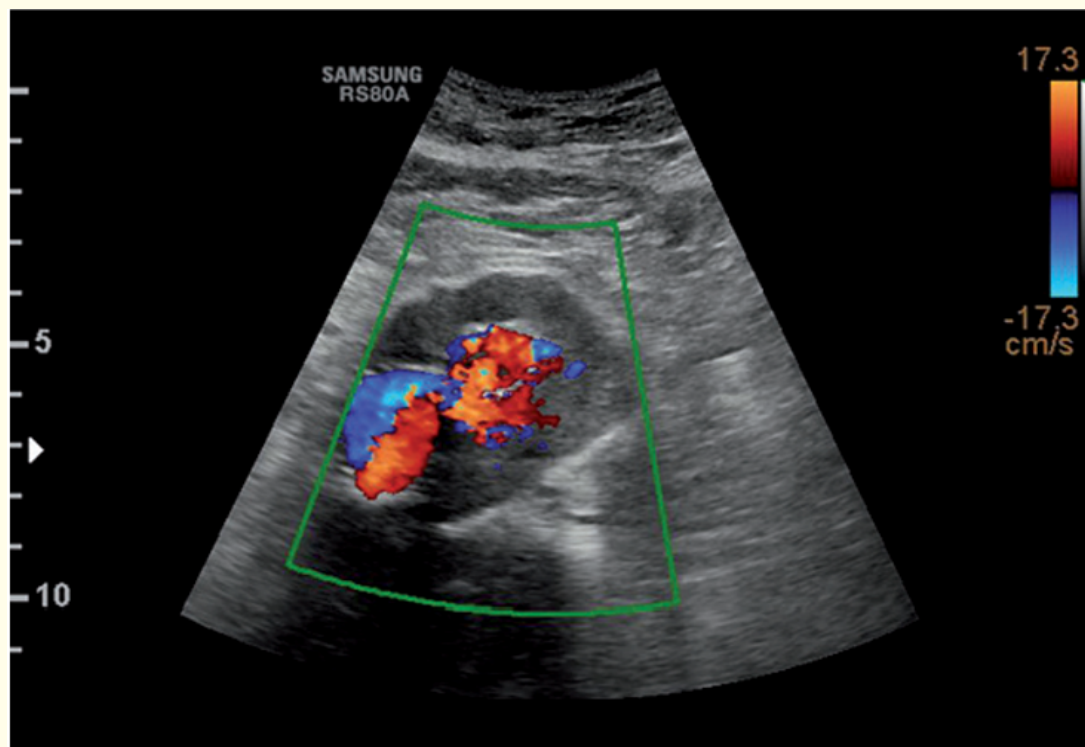


Figure 6: Same patient as in Figure 5 Color Doppler shows no vascularization outside the lumen of the stent.

An endoleak is a persistent blood flow within the aneurysm sac following the endovascular aneurysm repair, caused by incomplete sealing or exclusion of the aneurysm sac. The inflow or reflux of blood into the sac causes continued pressurization of the aneurysm and may leave the patient at risk for rupture [7]. It is said that roughly 20 to 50 percent of patients experience endoleaks post surgery. Endoleaks may be identified on completion of arteriography at the time of endovascular graft placement or later during follow-up at the time of endograph surveillance imaging. Increasing use of endovascular techniques for abdominal aortic aneurysm (EVAR) has also increased the frequency of complication due to these procedures. The risks are categorized in a classification system using types of endoleaks ranging from Type I to Type V. Type I endoleak occurs when there is a gap between the graft and the vessel wall. The gap allows blood to flow along the side of the graft into the aneurysm sac, which creates pressure within the sac increasing chance of rupture. This often occurs when the aneurysm is not suitable for EVAR or graft placed in the wrong location. It can also be caused as the vessel dilates over time. This type of endoleak requires immediate attention as it carries a high risk of rupture. Type II endoleak results when increased pressure within the side branches of the aorta force blood to leak back into the lower pressure aneurysm sac. This is considered to be the most common type of endoleak and is considered benign. Type III endoleak results from a misalignment between the components of endografts. This causes systemic pressure within the aneurysm sac which increases risk of rupture and requires immediate medical attention. Type IV endoleak occurs soon after some EVAR procedure due to the porosity of certain graft materials. Type V endoleak sometimes called endotension, it not considered to be a true leak but is defined to be a continued expansion of the aneurysm sac greater than 5 cm, without radiographic evidence of a leak site after the patient has any endovascular aneurysm repair. It is thought to occur when increased graft permeability allows pressure to be transmitted into the aneurysm sac. Regular follow-ups and ultrasonography can help detect endoleaks after having a EVAR procedure.

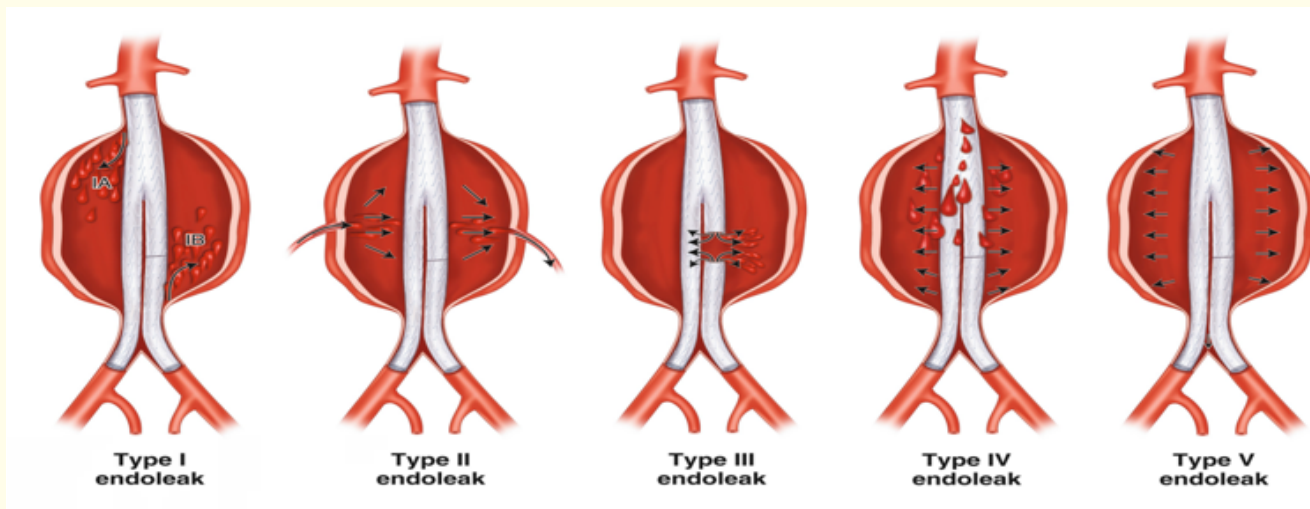


Figure 7: Types of Endoleaks due to EVAR procedure.

- **Type I:** Occurs when there is a gap between the graft and the vessel wall. The gap allows blood to flow along the side of the graft and into the aneurysm sac, causing increased pressure and increasing risk for rupture.
- **Type II:** Increased pressure within the side branches of the aorta force blood to leak back into the lower pressure aneurysm sac, often unpredictable.
- **Type III:** Caused by a defect within the graft material or due to structural failures causing separation between the components. These endoleaks require immediate attention because there is direct communication between the systemic circulation and the aneurysm sac.
- **Type IV:** May occur soon after an EVAR procedure due to the porosity of certain graft materials.
- **Type V:** Also known as endotension, an enlarging aneurysm sac without a visible endoleak.

Types of abdominal aortic aneurysms include Fusiform, Saccular, and Dissecting. A fusiform AAA is an all-around focal dilation of aortic aneurysm, it bulges or balloons out on all sides of the aorta. It is mainly found in the infrarenal region of the aorta or distal aorta. This is the most common of all abdominal aortic aneurysms and is usually a result of atherosclerosis.

A saccular shaped aneurysm bulges or balloons out only on one side of the blood vessel wall. Saccular AAA is most commonly seen in the abdominal aorta due to trauma.

A dissecting aneurysm is an aneurysm in which the wall of an artery dissects or rips due to tearing of the tunica intima and the separation between the tunica intima and tunica media. This occurs because the bleeding into the weakened wall splits the aortic wall. Two ways of identifying dissecting AAA is determining whether it includes the true lumen or false lumen. Dissecting aneurysms mostly arise from the thoracic aorta and radiate down to the abdominal aorta. The common causes of dissecting AAA include, Turners Syndrome (uncontrolled high blood pressure, heart problems and various heart conditions), Marfan Syndrome (condition in which connective tissue which supports structures in the body are weak), and sexually transmitted diseases such as syphilis.

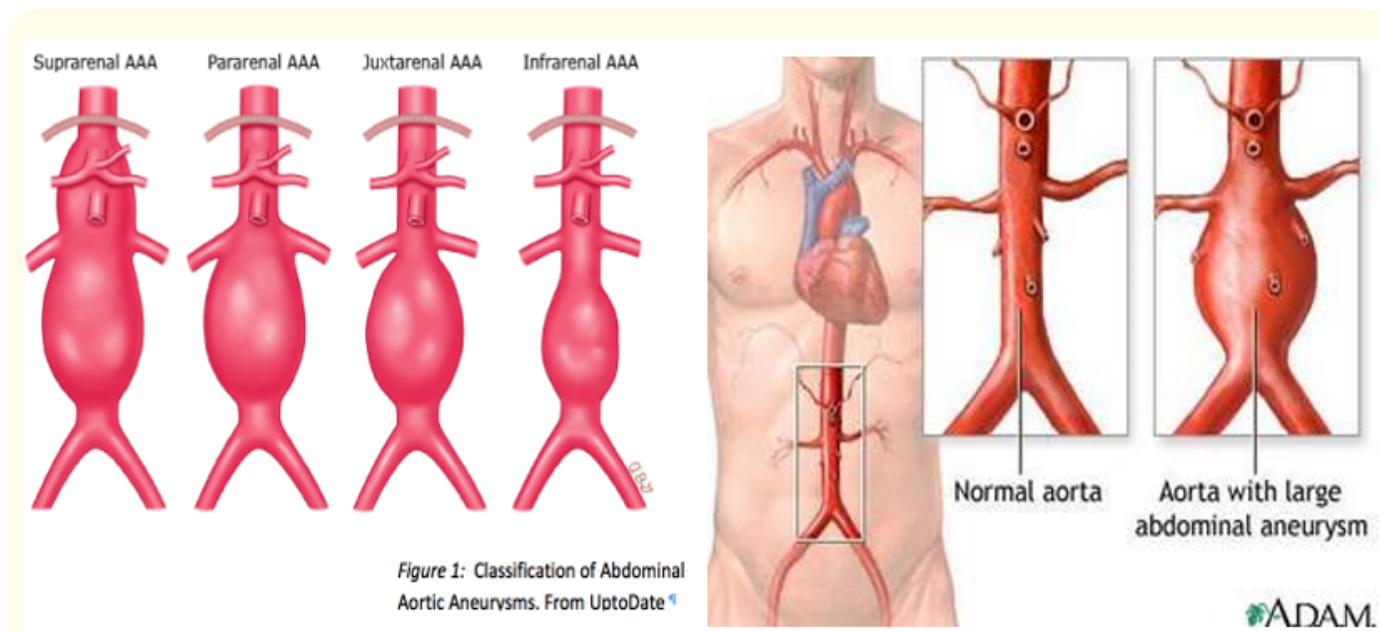


Figure 8 and 9: Showing classifications of abdominal aortic aneurysm.

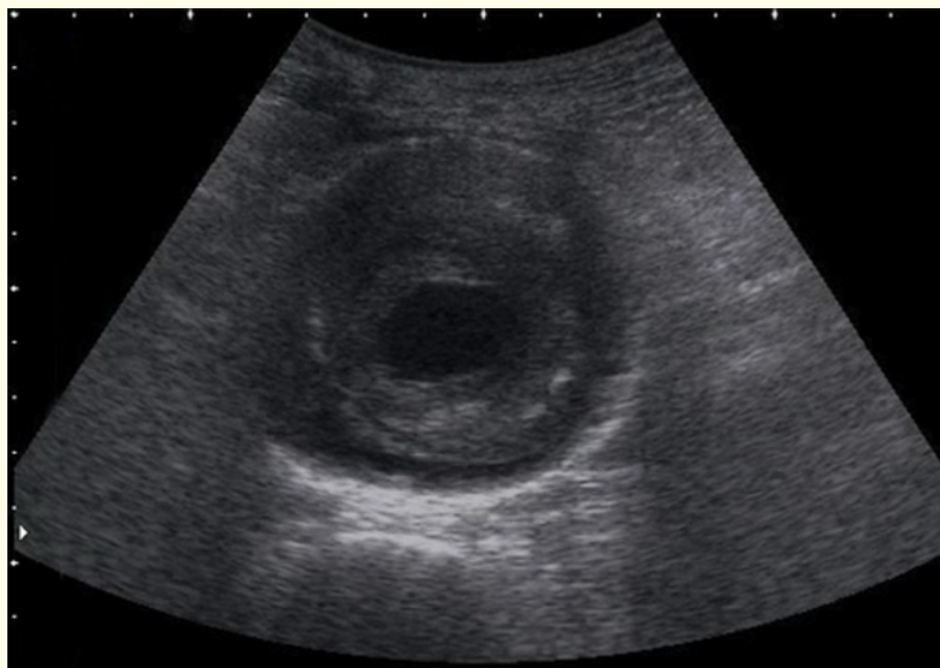


Figure 10: Fusiform AAA is one of the types of AAA the dilation is equal in both sides and looks hypoechoic with enhancement behind it and lateral shadow.

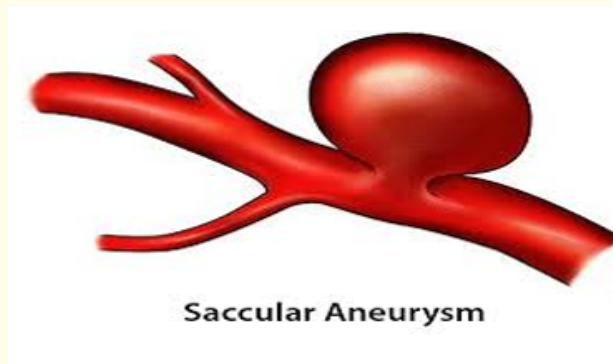


Figure 11: AAA Saccular, This is a focal dilation of just one side of the Aorta. The complications are same as Fusiform, such as stasis in the dilated area. In this image, anterior wall of AO has a sac like structure protruding, along with the stasis.



Figure 12: In transverse plane, Saccular AAA dilation is measure from outer to outer, and also the Aorta true lumen. It has an enhancement behind it and edge refracting shadows. The borders are usually obscured.

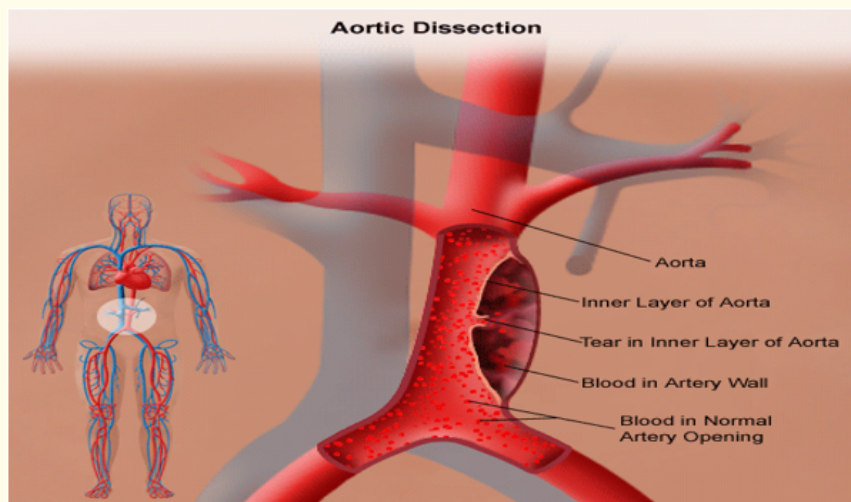


Figure 13: Aortic Dissection

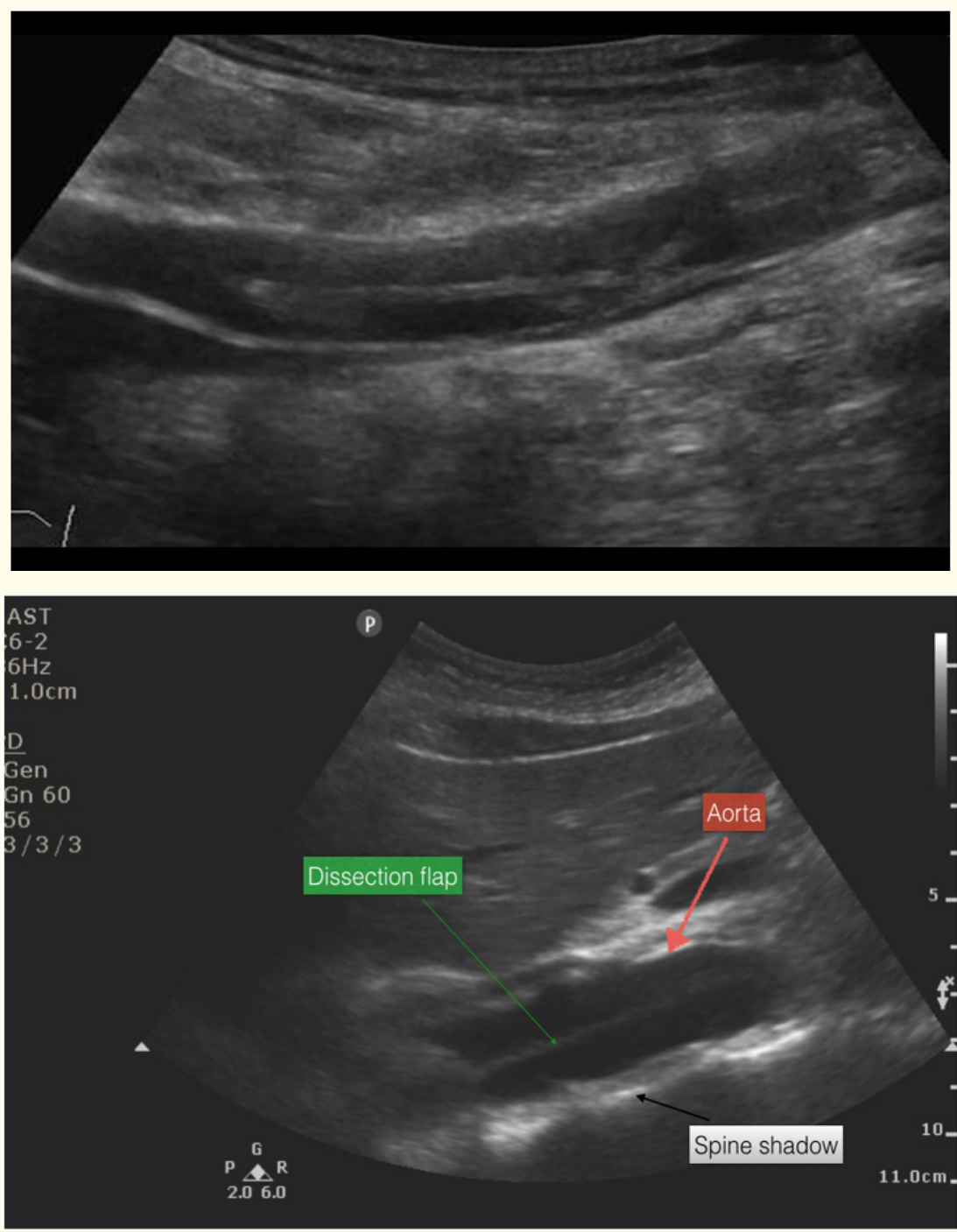


Figure 14 and 15: AAA Dissecting, The sonographic image will show the intimal flapping signs. This sign will consist of true lumen and false lumen. This can radiate throughout the Aortic vessel, and cause excruciating pain. Color doppler will help in diagnosing this type of AAA.

Another considered form of abdominal aneurysm is a pseudoaneurysm, which is not truly an aneurysm. Pseudoaneurysm or false aneurysm is a life threatening and rare condition due to aortic injuries or traumatic effects due to surgical or diagnostic interventions. It is not an enlargement of any diameter of the aorta but the leaking is due to the damage of the vessels wall due to trauma. Ultrasonography is very helpful to diagnose this aneurysm because it has a neck that shows bidirectional flow with color. Blood flow can also be seen outside of the aorta and is limited by the formation of pseudo layer created by the body.

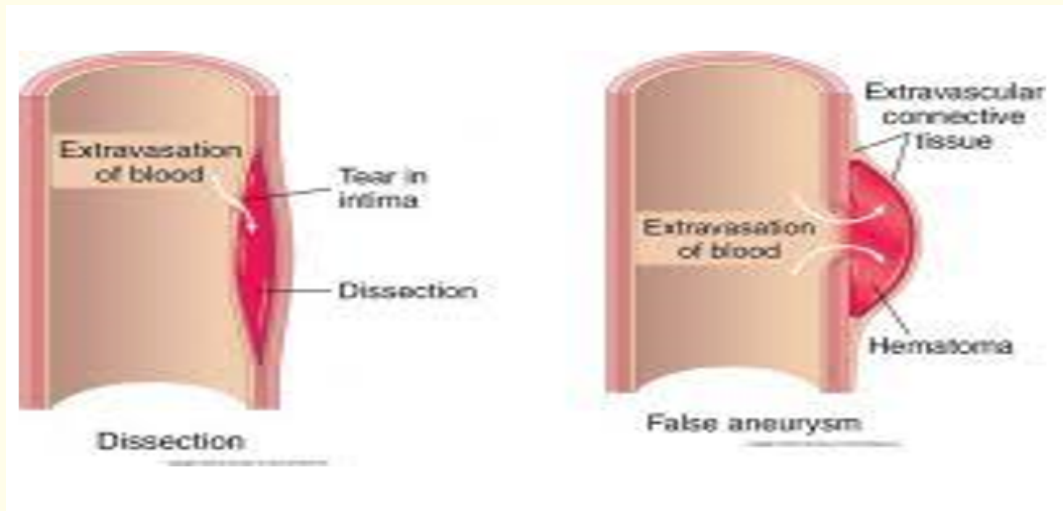

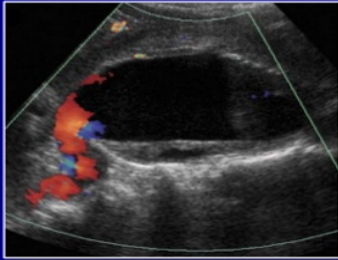


Figure 16

Abdominal aortic aneurysm / Rupture
High mortality rate (90%)

 <p>AAA with peripheral thrombus Small hypoechoic area (wall rupture) Hypoechoic structure at upper end</p>	 <p>Presence of active bleeding No further imaging confirmation Taken directly to OR</p>
--	--

Bhatt S et al. Ultrasound Clin 2007 ; 2 : 437 – 453.

Figure 17: Pseudoaneurysm, In this image, the color doppler shows the to and fro movements represented by blue and red color. This to and fro movement can cause turbulences, and cause stasis near the lumen which is represented by the hyperechoic stasis.

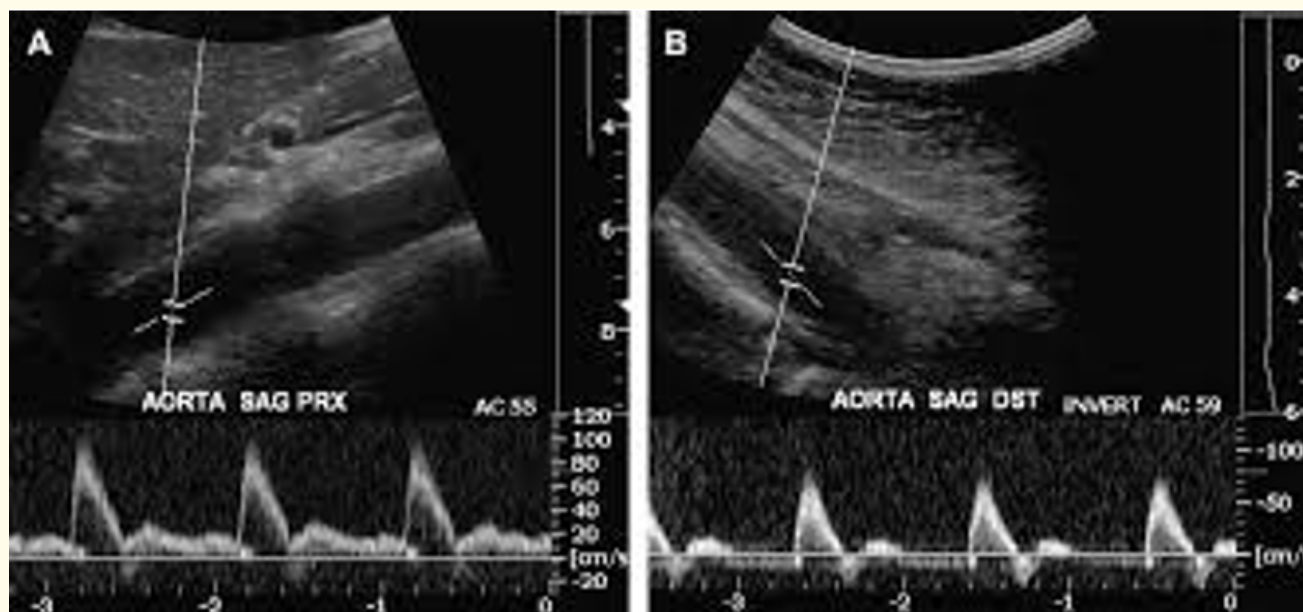


Figure 18: Spectral Doppler waveform of the (A) proximal and (B) distal aorta demonstrate a high resistance monophasic waveform proximally and a triphasic waveform distally.

Many methods can be used in diagnosing abdominal aortic aneurysms including CT, MRI and Ultrasound. Ultrasound has been found to be a specific and simple method of detection and evaluation. In addition, there are no risk factors associated with ultrasound examination as there are with CT and MRI, including exposure to ionizing radiation. Abdominal aortic ultrasound is preferably done after 6 - 8 hours of fasting in order to reduce bowel gas and provide a better image. The standard protocol for scanning the abdominal aorta consists of obtaining longitudinal and transverse images from the level of the diaphragm to the level of bifurcation of the aorta. Abdominal aortic diameter is recorded at the proximal, mid, and distal aorta, along with measurement of the common iliac arteries just distal to the bifurcation. The inferior vena cava is also evaluated to document normal flow. The procedure is performed with the patient laying in a supine position, right and left lateral decubitus or right and left posterior oblique positions. Usually 2.5 to 5 MHz sector, curvilinear array transducers are used for optimal visualization of the aorta. Sonographically the normal aorta has an anechoic, echo-free lumen with echogenic wall. Color flow doppler is helpful in determining the direction of blood flow in the aorta. The color box should be kept small which helps improve the frame rate and enhances the color resolution of the image. Some methods of optimization includes the color box, doppler gain, color scale, beam steering, gate size, wall filter and focal zone. Limitations of sonography include bowel gas, abdominal pain and obesity which may alter the image [15-20].

Conclusion

In conclusion, abdominal aortic aneurysms usually present without any symptoms and are frequently discovered during routine physical examination for other health issues. Application of ultrasound is an accurate, efficient and safe method used in diagnosing and evaluating abdominal aortic aneurysms and emergency situations concerning AAA rupture. Ultrasonographic imaging is also very helpful in monitoring patients after endovascular procedures for routine wellness and in diagnosing endoleaks associated with post-surgical pro-

cedures. Technological advancements have made ultrasound the preferred imaging modality for screening and follow up cases concerning AAA. In addition to ultrasound, CT is helpful in determining the rapid growth of an AAA and the need for immediate surgical intervention.

Acknowledgements

Dr. Naand Panjwani, Director of New York Medical Career Training Center Staffs at New York Medical Career Training Center.

Bibliography

1. Hirsch AT, *et al.* "ACC/AHA 2005 Practice Guidelines for the management of patients with peripheral arterial disease (lower extremity, renal, mesenteric, and abdominal aortic): A collaborative report from the American Association for Vascular Surgery/Society for Vascular Surgery, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, Society of Interventional Radiology, and the ACC/AHA Task Force on Practice Guidelines (Writing Committee to Develop Guidelines for the Management of Patients With Peripheral Arterial Disease): Endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation National Heart, Lung, and Blood Institute Society for Vascular Nursing Trans-Atlantic Inter-Society Consensus and Vascular Disease Foundation". *Circulation* 113.11 (2006): e463-e654.
2. Ouriel K, *et al.* "An evaluation of new methods of expressing aortic aneurysm size: Relationship to rupture". *Journal of Vascular Surgery* 15.1 (1992): 12-18.
3. Silverberg E., *et al.* "Cancer statistics, 1990". *CA: A Cancer Journal for Clinicians* 40.1 (1990): 9-26.
4. McPhee JT, *et al.* "The impact of gender on presentation, therapy, and mortality of abdominal aortic aneurysm in the United States, 2001-2004". *Journal of Vascular Surgery* 45.5 (2007): 891-899.
5. Roshanali F, *et al.* "Abdominal aorta screening during transthoracic echocardiography". *Echocardiography* 24.7 (2007): 685-688.
6. Kpodonu J., *et al.* "Intravascular ultrasound imaging as applied to the aorta: a new tool for the cardiovascular surgeon". *Annals of Thoracic Surgery* 86.4 (2008): 1391-1398.
7. "Endoleak and the Role of Embolization" (2015).
8. Mustafa R Bashir, *et al.* "Endoleaks After Endovascular Abdominal Aortic Aneurysm Repair: Management Strategies According to CT Findings". *Vascular and Interventional Radiology* (2009).
9. "Abdominal Aortic Aneurysm Repair".
10. Ultrasound tips and tricks.
11. Shweta Bhatt., *et al.* "Sonographic Evaluation of the Abdominal Aorta". *Ultrasound Clinics* (2007).
12. Piccinato CE., *et al.* "Mycotic aneurysm of the abdominal aorta". *Revista Paulista de Medicina* 108.2 (1990): 52-56.
13. Ting AC., *et al.* "Surgical treatment of infected aneurysms and pseudoaneurysms of the thoracic and abdominal aorta". *American Journal of Surgery* 189.2 (2005): 150-154.
14. Noel AA., *et al.* "Ruptured abdominal aortic aneurysms: The excessive mortality rate of conventional repair". *Journal of Vascular Surgery* 34.1 (2001): 41-46.

15. Tamer W Kassem., *et al.* "Follow up CT angiography post EVAR: Endoleaks detection, classification and management planning". *The Egyptian Journal of Radiology and Nuclear Medicine* 48.3 (2017): 621-626.
16. Chung Jayer. "Epidemiology, Risk Factors, Pathogenesis, and Natural History of Abdominal Aortic Aneurysm". Up to Date (2018).
17. "Endoleaks (Type I-V)".
18. "Patient education: Abdominal aortic aneurysm (Beyond the Basics)".
19. "Abdominal Aortic Aneurysm Epidemiology".
20. Abdominal Aortic Aneurysm (AAA).

Volume 5 Issue 12 December 2018

©All rights reserved by M Ayub Hussain., *et al.*