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Original Article

Computed Tomographic Characteristics of Abdominal Aortic Aneurysms Cases at Tertiary Hospital in resource limited setup: A Retrospective Analysis

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Abstract
Background: *Abdominal aortic aneurysm (AAA) is a life-threatening vascular condition characterized by an abnormal focal dilation of the abdominal aorta. Due to the high mortality associated with rupture, early detection and intervention are critical. This study aims to determine the CT characteristics of AAA cases and the prevalence of rupture at Tikur Anbessa Specialized Hospital, Ethiopia*
Methods: *We conducted a retrospective record review from May 1, 2022, to May 1, 2023, analyzing abdominal CT images of 38 patients diagnosed with AAA. Data on aneurysm location, size, morphology, and complications were collected. Descriptive and inferential statistical analyses were employed to explore the associations between these factors and the risk of aneurysm rupture.*
Results: *Among the 38 cases of AAAs, 33(86.8%) were infra-renal with a median transverse diameter of 57.15 mm (IQR: 48.58 - 77.23). Twenty-five (65.8%) of AAAs were fusiform. Rupture was identified in 13(34.2%) of cases, with 10(26.3%) of cases being contained. Thrombus was observed in 30(78.9%) of AAA cases. Although traditional predictors of rupture, including AAA size, location, morphology, gender, and age, were observed, none reached statistical significance in this analysis. The odds of rupture were 21% lower in males compared to females, but this difference was not statistically significant (OR = 0.791, 95% CI: 0.206, 3.032)*
Conclusion: *This study identified the clinical presentations and morphologic characteristics of AAAs at presentation in Ethiopia. It also demonstrated that some patients presented with rupture, emphasizing the necessity of early detection and tailored management strategies to reduce rupture risks.*

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Background

Abdominal aortic aneurysm (AAA) is a life-threatening vascular condition characterized by an abnormal focal dilation of the abdominal part of the aortic wall, and is defined as a diameter exceeding 30 mm or an increase of at least 50% over the normal adjacent segments.(1,2) AAAs are often localized at the level of the infrarenal aorta and are considered a degenerative disease of aging.(3)

Globally, aortic aneurysms, both thoracic (TAA) and abdominal (AAA), is estimated to cause 150,000 to 200,000 deaths annually.(4) The prevalence of AAA varies between 2% and 12%, with approximately 8% of men over the age of 65 years.(5) AAAs are four to six times more common in males than in females.(6) The mechanisms underlying the development and progression of AAAs are multifactorial, involving both acquired risk factors and genetic predisposition. Age significantly impacts the incidence of AAAs, with the risk increasing by 40% every 5 years after the age of 65. Smoking is another strong risk factor, with the duration of smoking being more critical than the number of cigarettes smoked daily. Other key risk factors include positive family history, atherosclerosis, hypertension, and male sex.(7–9)

AAAs are typically asymptomatic, but carry the risk of serious complications, including rupture, which dramatically increases mortality rates. Early detection through imaging is crucial, as the survival rate for ruptured AAAs is only about 20% even with intervention.(10) The likelihood of rupture correlates with aneurysm size, rhe annual rupture risk ranging from negligible for diameters below 4.0 cm to as high as 50% for diameters exceeding 8.0 cm.(11,12) Elective surgical interventions are recommended for aneurysms larger than 5.5 cm in otherwise healthy individuals.(13,14) Non-invasive assessment of abdominal aortic aneurysms (AAA) can be performed using computed tomography angiography (CTA), magnetic resonance angiography (MRA), or ultrasound. Ultrasound is recommended for initial screening due to its high sensitivity and specificity, though it can be limited by bowel gas and body habitus. CTA is often preferred, especially for endovascular aneurysm repair (EVAR) planning, due to its superior spatial resolution, reproducibility, and reduced operator dependence. (7,9,15). Despite poor prognosis pertaining to AAAs, studies on AAAs are limited in sub-Saharan Africa, particularly in Ethiopia. The absence of comprehensive data on the characteristics of AAA and the prevalence of ruptures in Africa significantly impedes the development of effective screening and management strategies tailored to this population. This retrospective study aims to analyze the clinical presentation and morphologic characteristics of AAAs and the prevalence of ruptures among diagnosed cases.

Methods

Study Design and Population

This retrospective record review was conducted at Tikur Anbessa Specialized Hospital (TASH), Addis Ababa University, Ethiopia, from May 1st, 2022, to May 1st, 2023. A total of 38 AAA cases were included in the study after reviewing all abdominal aortic aneurysm (AAA) cases who had undergone a post-contrast abdominopelvic CT scan during the study period, including CT angiography, arterial phase, or portal venous phase CT. Our inclusion criteria were cases of AAA with a contrast-enhanced abdominopelvic CT scan and no prior vascular surgical intervention at the time of CT imaging. We excluded cases with incomplete CT images or no clear record of previous clinical data.

Data Collection

Data were- collected retrospectively by reviewing logbooks from the Radiology department and vascular surgery unit, patient charts, and electronic records to cross-check the availability of clinical data and abdominopelvic CT studies. CT reports were retrieved from the TASH med-web database and the surgery department's image collections. Due to missing or incomplete CT reports, all CT studies were assessed by an abdominal and pelvic imaging fellow, the principal investigator (PI), and reviewed by an abdominal and pelvic imaging subspecialist.

All studies were done by multidetector CTs of either 64 or 128 slices of different brands (General Electric, Siemens and Philips) with contrast administered with automatic injectors. Scan was done with patient supine and the distal thoracic aorta and common femoral arteries were included in the study. Then the raw data were reconstructed in 5mm scan in axial, coronal and sagittal sections. For measurement of the angles, oblique reconstructions were done as needed. All images were reviewed using radiant DICOM viewer.

The site of the abdominal aortic aneurysm in relation to the most proximal renal artery branch-off was determined. The size of the AAA in longitudinal, transverse, and anteroposterior dimensions was measured in millimeters (figure 1 & 2). We assessed whether the splanchnic and iliac vessels were involved and measured the length and diameter of the iliac arteries to determine tortuosity and ectasia. The morphology of the aortic aneurysm was classified as fusiform, saccular, mixed, or pseudo-aneurysm. The presence of thrombosis, mural, and thrombus calcifications, and features suggestive of AAA rupture or imminent rupture were also determined. Data management was ensured through a data collection table, regularly checked by the coauthors of this manuscript.

Statistical Analysis

Descriptive statistics were used to summarize anatomical and morphological characteristics. The normality of continuous variables was assessed using the Shapiro-Wilk test. For normally distributed variables, means and standard deviations were reported, and group comparisons were made using independent samples t-tests. For non-normally distributed variables, medians and interquartile ranges (IQRs) were reported, and comparisons were performed using the Mann-Whitney U test. Categorical variables were summarized as frequencies and percentages, and associations between these variables were examined using Chi-square tests or Fisher's exact tests, as appropriate. Statistical significance was set at $P < 0.05$. All statistical analyses were conducted using SPSS version 29.0.2.0 (20).

Ethical clearance

The research has got an ethical clearance from the department of surgery, Addis Ababa University. All patient identifiers were removed from the data collection tool and information was used only for the research purpose. Ethical clearance letter reference number is 12.

Result

Sociodemographic characteristics

In this retrospective analysis, we evaluated 38 CT images of patients diagnosed with abdominal aortic aneurysms (AAA), with an equal distribution of males and females. (Table 1) The age of the patients

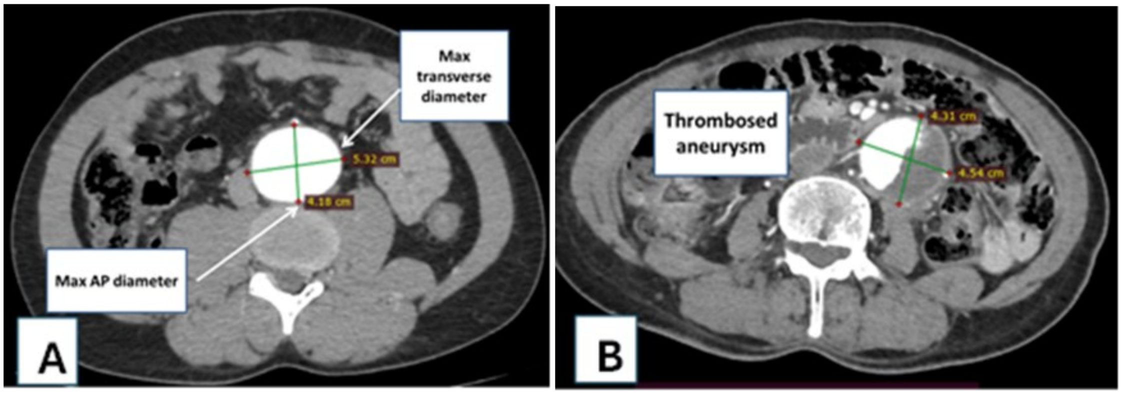

Figure 1: mages A and B shows maximum anteroposterior and transverse diameter measurement of abdominal aortic aneurysm inI non-thrombosed and thrombosed aneurysms

ranged from 11 to 85 years, with a mean age of 53.24 years (SD = 20.46). The median age for males was 52 years (IQR: 35-70), while for females it was 60 years (IQR: 35-70). However, we did not observe a significant difference in age distribution between males and females (p = 0.644).

Anatomic and Morphologic Characteristics

Among the 38 cases, 33(86.6%) of the aneurysms were located infra-renally, while 2(5.3%) and 3(7.9%) were suprarenal and juxta-renal aneurysms respectively. The median diameters of the aneurysms were 57.15 mm transversely (IQR: 48.58–77.23), 54.6 mm anteroposteriorly (IQR: 44.03–74.15), and 84.95 mm longitudinally (IQR: 66.75–119.93). The transverse, longitudinal, and AP diameters were over 40 mm in 36 (94.74%), 37 (97.37%), and 33 (86.84%) AAAs, respectively. Morphologically, the most frequent aneurysm shape was fusiform 25(65.80%), followed by pseudo-aneurysm 8 (21.1%), saccular 4(10.5%), and mixed fusiform-saccular 1(2.6%,). The proximal neck length (PNL) had a median of 29.4 mm (IQR: 14.45–48.70), with 55.26% (n = 21) of the cases having an adequate PNL and 9 (23.68%) having a PNL of less than 10 mm. The median proximal neck diameter of our AAA cases was 18.0 mm (IQR: 14.8–20.4).

In this study, one case featured a complex thoracoabdominal type juxta-renal aneurysm affecting both renal arteries with a proximal neck diameter of 26.60 mm. Another case involved a juxta-renal pseudo aneurysm extending to the left renal artery, resulting in infarction, with the suprarenal aorta maintaining a normal size and no measurable proximal neck length.
The involvement of the inferior mesenteric artery (IMA) was observed in 28 (73.6%) cases, with 21(55.3%) arising from the non-thrombosed lumen and 7(18.4%) from the thrombosed part, all showing normal contrast opacification without bowel ischemia. Iliac artery (CIA) involvement was noted in 14(36.8%) of cases, with 7 (18.4%) of AAA cases only involving the right, 3 (7.9%) only involving the left, and 4(10.5%) involving both arteries.

Table 1: Anatomical characteristics of aneurysms

Variables		Frequency (%)	P-values
Gender	Males	19(50%)	0.117
Age (years)	<50	21(55.3%)	0.730
	>50	17(44.7%)	
Location	Infra-renal	33(86.8%)	0.439
	Supra-renal	2 (5.3%)	
	Juxta-renal	3 (7.9%)	
Morphology	Fusiform	25 (65.8%)	0.493
	Pseudo-aneurysm	8 (21.1%)	
	Saccular	4 (10.5%)	
	Mixed	1 (2.6%)	
Thrombosis		30 (78.9%)	0.826
Type	Homogeneous	21(70%)	0.030*
	Heterogeneous	9(30%)	
Calcifications		17(44.73%)	0.334
Type	Discontinuous	14(82.3%)	1.000
	Continuous	3(17.7%)	
IMA involved		28(73.6%)	0.263
CIA Involved		14(36.8%)	1.000

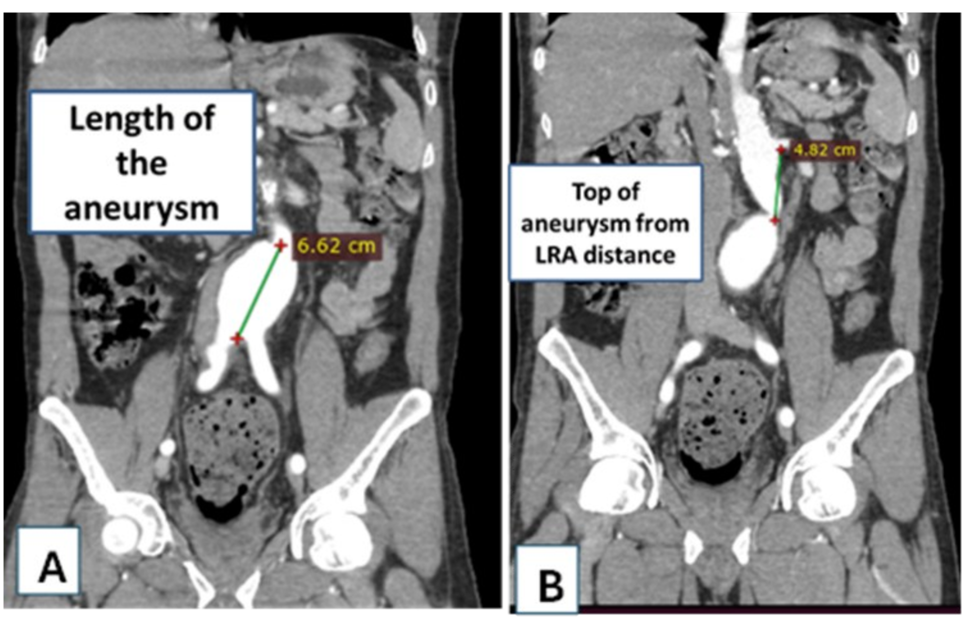

Figure 2: images A and B shows maximum longitudinal measurement and length of the aneurysmal neck of the abdominal aortic aneurysm

Aneurysm Rupture and other complications

We identified AAA rupture in 13(34.2%) cases, with 10 (26.3%) contained ruptures and 3(7.9%) non-contained ruptures. Rupture sites were equally distributed between posterior and anterolateral locations 5(38.5%) each, with three cases (23.1%) having indeterminate locations. We observed impending rupture features in one case. Although there was a 21% reduction in the odds of being diagnosed with a ruptured abdominal aortic aneurysm among male patients compared to female patients, this reduction was not statistically significant (OR = 0.791, 95% CI: 0.206, 3.032). The median age was similar across both intact and ruptured groups, with a median of 55 (IQR 35-70) years for intact and 56 (IQR 35-70) years for ruptured cases (p = 0.976). No statistically significant difference was observed between ruptured and intact AAAs in respect to the values of median AP Diameter, Transverse Diameter, Longitudinal Dimension, and Proximal Neck Diameter (Table 2). Although not statistically significant, the median proximal neck length was lower in patients with ruptured AAAs compared to those with intact AAAs (p = 0.130). Similarly, the maximum diameters of the left and right common iliac arteries were slightly lower in ruptured cases, while the median Alpha Angle and Beta Angle were higher in the ruptured group. None of these differences reached statistical significance (see Table 2).

Table 2: Characteristics of ruptured and intact aneurysms

	Median(IQR)/ Mean + SD			
Variables	Overall (N=38)	Intact (n=25)	Ruptured (n=13)	P-value
Age (years)	55.5(35.0 -70.0)	55(35-70)	56(35-70)	0.976
AP Diameter	54.6(44.0 -74.2)	54.2(43.5-68.0)	56.6(45.4-98.6)	0.329
Transverse Diameter	57.2(48.6 -77.2)	56.5(46.6-76.1)	60.8(53.2-91.8)	0.110
Longitudinal Dimension	84.9(66.8 - 119.9)	80.0(66.0-108.0)	88.3(67.2-153.0)	0.300
Proximal Neck Diameter	18.0(14.8 - 20.4)	17.0 (13.7-20.0)	19(17.4-25.3)	0.178
Proximal Neck length	31.7 + 21.9	35.5 + 22.7	23.8 + 18.6	0.130 *
Alpha angle	67.4 + 38.5	63.8 + 36.9	76.9 + 45.2	0.533 *
Beta Angle	81.1 + 38.6	74.9 + 40.6	97.3 + 30.5	0.283 *
LCIA Maximum	13.5(11.7 - 17.0)	14.0(11.8-16.7)	13.0(9.9-18.8)	0.976
RCIA Maximum	14.0(11.7 - 19.0)	15.4(11.9-19.0)	13.5(10.3-18.3)	0.808
Length of RIA	47.9(38.5 - 60.3)	45.0(36.5-60.0)	52(43.4-70.5)	0.178
Length of LIA	51.6(40.0- 60.0)	47.0(39.5-65.0)	57(50.5-60.0)	0.246
Lumen: Thrombus	2.1(1.5 - 2.8)	2.0 (1.4-3.6)	2.2(1.5-2.5)	0.588

*Independent sample t-test

Thrombus was identified in 30(78.9%) of AAAs, with equal distribution between eccentric and concentric locations. Of the 30 AAAs with thrombus, thrombus calcification was observed in 3 cases (10%). The median lumen-to-thrombus ratio was 2.09(IQR 1.475 - 2.763). Mann-Whitney U test did not show a significant difference in the distribution of the lumen-to-thrombus ratio between ruptured and intact AAA cases (p= 0.588). Thrombus morphology was homogeneous in 70% (n=21) and heterogeneous in 9(30%). Fisher's Exact Test revealed an association between aneurysm rupture status and thrombus morphology (p = 0.03). Among ruptured aneurysms, 60% had a heterogeneous thrombus, compared to 15% of intact aneurysms. Mural calcifications representing atherosclerosis were observed in 17(44.73%) of the cases, with 14(82.3%) being discontinuous calcification, and only a few 3(17.7%) cases of continuous calcification.

Discussion

Despite the decline in the burden of AAA in the developed world, the burden and characteristics of AAA in Africa are not well studied.(4,16) Our cross-sectional study provides critical insights into the computed tomographic characteristics of abdominal aortic aneurysms (AAA) and the magnitude of ruptured AAAs on CT scan at TASH, contributing to a growing understanding of this significant health issue within the region. More than 50% of AAA cases in Africa are identified incidentally, and about one-third of the cases present with aortic rupture, with mortality rates ranging from 65-72%.(16) In our study, the prevalence of rupture at the time of AAA diagnosis by imaging was 34.2%, reflecting the possibility of a delayed diagnosis.

In terms of location and morphology, our study found that infrarenal AAAs were the most common, accounting for 86.8% of cases, with fusiform morphology predominant in 65.8% of cases. These findings are consistent with previous literature, which also identified infrarenal AAAs as the most common type and fusiform morphology as the most frequent shape.(5,17) AAA patients in our study presented at a younger age, with a median age of 55.5 years and 55.3% of cases occurring before 50. This aligns with Kenyan studies which reported a mean age of 56.15 years, with over 20% of cases under 40.(18) However, this is significantly less than the mean age of 72.5 years reported in a Chinese study(19) and the ages of 71.5 years for intact and 75.8 years for ruptured AAAs reported in Finland.(20) In contrast to high-income countries where AAA is mainly degenerative and affects those over 70, it often occurs at younger age in Africa and believed to be associated with an infectious etiology.(21) We also observed a comparable distribution of AAA cases by sex, which is in contrast with other studies that reported that men accounted for 89% of AAA cases in Africa.(16) Similarly, Iranian study found 84% , and 80.4% in Mexico.(17,22) Although studies suggest women generally have a lower prevalence of AAA, their aneurysms tend to grow faster and are four times more likely to rupture during surveillance even after adjusting for age.(23) The discrepancies shown in our study could be explained by small sample size used in our series. In -addition the study was done in a single institution where most patients are referred for surgical interventions, so further multicenter studies with large sample size is recommended. Our study showed consistent findings with 21% lower odds of being diagnosed with a ruptured AAA among male patients compared to female patients, although this difference was not statistically significant.

Aneurysm size and growth rate are the primary predictors of abdominal aortic aneurysm (AAA) rupture, with aneurysms exceeding 5.5 cm in diameter and those expanding more than 1 cm annually posing a considerably higher rupture risk.(24–26) Other important risk factors include poorly controlled hypertension, smoking, advanced age, family history of AAA, saccular morphology, the presence of intraluminal thrombus, and systemic inflammation. (5,9,27,28). Although we observed a higher median diameter in ruptured aneurysms compared to intact ones, 60.8 mm (IQR 53.2-91.8) vs. 56.5 mm (IQR 46.6-76.1), no significant association with rupture risk was found. Similarly, aneurysm morphology and the lumen-to-thrombus ratio were not significantly associated with rupture. The lack of association in our study may be attributed to reliance on single observations, estimation of post-rupture diameter, and the retrospective design without follow-up CT imaging. These limitations could have led to an underestimation of the median diameter and the association of other predictors with rupture. We identified intraluminal thrombus (ILT) in 78.9% of AAAs, aligning with reports indicating ILT could be present in 70-80% of cases.(29) However, the 10% rate of thrombus calcification observed in our study was notably lower than the 25% previously reported, underscoring variability in thrombus characteristics.(30) Both the presence of ILT and its calcification correlate with increased rupture risk, with ILT-induced hypoxia weakening the aneurysm wall and calcification decreasing arterial elasticity.(31,32) These findings highlight the importance of comprehensive thrombus assessment in predicting AAA outcomes and guiding treatment strategies.

Among patients with abdominal aortic aneurysm (AAA), concomitant arterial aneurysms, particularly of the common iliac artery (CIA), are frequently reported, with CIA involvement documented in 20-40% of cases.(33). In our study, CIA involvement was observed in 36.8% of cases, and the inferior mesenteric artery (IMA) was involved in 73.6% of cases. Hostile neck anatomy is another major determinant of EVAR patient eligibility for treating AAAs and often directs the decision toward traditional open repair. According to Stather *et al.*, hostile neck anatomy is characterized by neck lengths shorter than 15 mm, diameters greater than 28 mm, or angulations exceeding 60 degrees. These anatomical features significantly increase the risk of complications such as endoleaks and graft migration during EVAR.(34,35) Our study recorded a median proximal neck diameter of 18.0 mm (IQR: 14.8 to 20.45 mm) and a mean neck length of 31.7 mm (SD = 21.9). While these measurements typically support the feasibility of standard EVAR procedures, the notable variability in anatomical dimensions highlights potential challenges. Due to technical difficulties, alpha and beta angles were determined in only 18 cases, because of some studies losing their resolution and information when they are reconstructed. With observed angles of 67.4 degrees (SD = 38.5) and 81.1 degrees (SD = 38.6), respectively. These findings emphasize the necessity for meticulous pre-operative assessment and the customization of surgical strategies to effectively manage the complexities presented by these anatomical variations and reduce the associated risks.

Conclusion

Our study reveals critical insights into the characteristics of abdominal aortic aneurysm (AAA) , highlighting a high rupture rate, younger age of presentation, and multi-arterial involvement. This underscores the need for large-scale epidemiological study in Ethiopia.

References

1. Golledge J, Thanigaimani S, Powell JT, Tsao PS. Pathogenesis and management of abdominal aortic aneurysm. Eur Heart J. 2023;44(29):2682-2697. doi:10.1093/eurheartj/ehad386
2. Chandrashekar A, Handa A, Lapolla P, et al. Prediction of Abdominal Aortic Aneurysm Growth Using Geometric Assessment of Computerized Tomography Images Acquired during the Aneurysm Surveillance Period. Ann Surg. 2023;277(1):E175-E183. doi:10.1097/SLA.0000000000004711
3. Bossone E, Eagle KA. Epidemiology and management of aortic disease: aortic aneurysms and acute aortic syndromes. Nat Rev Cardiol. 2021;18(5):331-348. doi:10.1038/s41569-020-00472-6
4. Wang Z, You Y, Yin Z, et al. Burden of Aortic Aneurysm and Its Attributable Risk Factors from 1990 to 2019: An Analysis of the Global Burden of Disease Study 2019. Front Cardiovasc Med. 2022;9. doi:10.3389/fcvm.2022.901225
5. Anagnostakos J, Lal BK. Abdominal aortic aneurysms. Prog Cardiovasc Dis. 2021;65:34-43. doi:10.1016/j.pcad.2021.03.009
6. Ullery BW, Hallett RL, Fleischmann D. Epidemiology and contemporary management of abdominal aortic aneurysms. Abdominal Radiology. 2018;43(5):1032-1043. doi:10.1007/s00261-017-1450-7
7. Hallett RL, Ullery BW, Fleischmann D. Abdominal aortic aneurysms: pre- and post-procedural imaging. Abdominal Radiology. 2018;43(5):1044-1066. doi:10.1007/s00261-018-1520-5
8. Lattanzi S. Abdominal aortic aneurysms: pathophysiology and clinical issues. J Intern Med. 2020;288(3):376-378. doi:10.1111/joim.13060
9. Sakalihasan N, Michel JB, Katsargyris A, et al. Abdominal aortic aneurysms. Nat Rev Dis Primers. 2018;4(1). doi:10.1038/s41572-018-0030-7
10. Heikkinen M, Salenius JP, Auvinen O. Ruptured abdominal aortic aneurysm in a well-defined geographic area. J Vasc Surg. 2002;36(2):291-296. doi:10.1067/mva.2002.125479
11. Brewster DC, Cronenwett JL, Hallett JW, Johnston KW, Krupski WC, Matsumura JS. Guidelines for the treatment of abdominal aortic aneurysms: Report of a subcommittee of the Joint Council of the American Association for Vascular Surgery and Society for Vascular Surgery. J Vasc Surg. 2003;37(5):1106-1117. doi:10.1067/mva.2003.363
12. Rokosh RS, Wu WW, Eskandari MK, Chaikof EL. Society for Vascular Surgery implementation of guidelines in abdominal aortic aneurysms: Preoperative surveillance and threshold for repair. J Vasc Surg. 2021;74(4):1053-1054. doi:10.1016/j.jvs.2021.04.068
13. Chaikof EL, Dalman RL, Eskandari MK, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. J Vasc Surg. 2018;67(1):2-77.e2. doi:10.1016/j.jvs.2017.10.044
14. Earnshaw JJ. The Indication for Elective Repair of Abdominal Aortic Aneurysm Should Be Reviewed. European Journal of Vascular and Endovascular Surgery. 2021;61(1):7-8. doi:10.1016/j.ejvs.2020.09.001
15. Karkos CD, Mukhopadhyay U, Papakostas I, Ghosh J, Thomson GJL, Hughes R. Abdominal aortic aneurysm: The role of clinical examination and opportunistic detection. European Journal of Vascular and Endovascular Surgery. 2000;19(3):299-303. doi:10.1053/ejvs.1999.1002
16. E N, J W, I C, R L, A H, Aneurysm. Prevalence and epidemiological pattern of abdominal aortic aneurysms in Africa: A systematic review. Journal of West African College of Surgeons. 2020;10(1):3. doi:10.4103/jwas.jwas_15_21
17. Arellano-Gutiérrez G, Rodríguez-Andrade AY, Murillo-Barrios IE. Abdominal aortic aneurysm characteristics and outcomes: a single-center retrospective cross-sectional study. Cirugia y Cirujanos (English Edition). 2023;91(6):730-735. doi:10.24875/CIRU.22000474
18. Ogeng'O JA, Olabu BO, Kilonzi JP. Pattern of aortic aneurysms in an African country. Journal of Thoracic and Cardiovascular Surgery. 2010;140(4):797-800. doi:10.1016/j.jtcvs.2009.11.023
19. Guo W, Zhang T. Abdominal aortic aneurysm prevalence in China. Endovascular Today. 2014;76
20. Laine MT, Laukontaus SJ, Sund R, et al. A population-based study of abdominal aortic aneurysm treatment in Finland 2000 to 2014. Circulation. 2017;136(18):1726-1734. doi:10.1161/CIRCULATIONAHA.117.028259
21. Wu L. Abdominal aortic aneurysm—The African experience. Journal of West African College of Sur-

geons. 2020;10(1):1. doi:10.4103/jwas.jwas_2000_20
22. Research O, Mehdi Forouzanfar M, Barazesh F, Hashemi B, Safari S. Archives of Academic Emergency Medicine. 2020; 8 (1): E4 Characteristics and Outcome of Abdominal Aortic Aneurysm in Emregncy Department; a 10-Year Cross-Sectional Study. http://journals.sbmu.ac.ir/aaem
23. Lo RC, Schermerhorn ML. Abdominal aortic aneurysms in women. J Vasc Surg. 2016;63(3):839-844. doi:10.1016/j.jvs.2015.10.087
24. Thompson SG, Brown LC, Sweeting MJ, et al. Systematic review and meta-analysis of the growth and rupture rates of small abdominal aortic aneurysms: implications for surveillance intervals and their cost-effectiveness. Health Technol Assess. 2013;17(41):1-118. doi:10.3310/hta17410
25. Kumar Y, Hooda K, Li S, Goyal P, Gupta N, Adeb M. Abdominal aortic aneurysm: Pictorial review of common appearances and complications. Ann Transl Med. 2017;5(12). doi:10.21037/atm.2017.04.32
26. Kontopodis N, Lioudaki S, Pantidis D, Papadopoulos G, Georgakarakos E, Ioannou C V. Advances in determining abdominal aortic aneurysm size and growth. World J Radiol. 2016;8(2):148. doi:10.4329/wjr.v8.i2.148
27. Schmitz-Rixen T, Keese M, Hakimi M, et al. Ruptured abdominal aortic aneurysm—epidemiology, predisposing factors, and biology. Langenbecks Arch Surg. 2016;401(3):275-288. doi:10.1007/s00423-016-1401-8
28. Karthaus EG, Tong TML, Vahl A, Hamming JF. Saccular Abdominal Aortic Aneurysms: Patient Characteristics, Clinical Presentation, Treatment, and Outcomes in the Netherlands. Ann Surg. 2019;270(5):852-858. doi:10.1097/SLA.0000000000003529
29. Piechota-Polanczyk A, Jozkowicz A, Nowak W, et al. The Abdominal Aortic Aneurysm and Intraluminal Thrombus: Current Concepts of Development and Treatment. Front Cardiovasc Med. 2015;2. doi:10.3389/fcvm.2015.00019
30. Li ZY, U-King-Im J, Tang TY, Soh E, See TC, Gillard JH. Impact of calcification and intraluminal thrombus on the computed wall stresses of abdominal aortic aneurysm. J Vasc Surg. 2008;47(5):928-935. doi:10.1016/j.jvs.2008.01.006
31. Vorp DA, Lee PC, Wang DHJ, et al. Association of intraluminal thrombus in abdominal aortic aneurysm with local hypoxia and wall weakening. J Vasc Surg. 2001;34(2):291-299. doi:10.1067/mva.2001.114813
32. Barrett HE, Cunnane EM, Hidayat H, et al. On the influence of wall calcification and intraluminal thrombus on prediction of abdominal aortic aneurysm rupture. J Vasc Surg. 2018;67(4):1234-1246.e2. doi:10.1016/j.jvs.2017.05.086
33. Studzińska D, Rudel B, Polok K, et al. Infrarenal versus Suprarenal Abdominal Aortic Aneurysms: Comparison of Associated Aneurysms and Renal Artery Stenosis. Ann Vasc Surg. 2019;58:248-254.e1. doi:10.1016/j.avsg.2018.10.044
34. Stather PW, Wild JB, Sayers RD, Bown MJ, Choke E, Stather P. Endovascular Aortic Aneurysm Repair in Patients with Hostile Neck Anatomy. Vol 20.; 2013. www.jevt.org
35. Pitros C, Kakkos S. Hostile neck anatomy of abdominal aortic aneurysms: Is it time for a solid up-to-date definition? Vasc Investig Ther. 2022;5(4):91. doi:10.4103/2589-9686.376922