CLINICAL AND SUBCLINICAL CHARACTERISTICS ON THORACIC AORTIC ANEURYSM PATIENTS TREATED BY ENDOVASCULAR REPAIR

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SUMMARY

Objectives: *To describe some clinical and subclinical characteristics of patients with thoracic aortic aneurysms (TAA) before endovascular repair.* ***Subjects and methods:*** *A descriptive study on clinical and subclinical features in 80 patients with TAA treated endovascular interventions under the guidance of a DSA or C-arm machine at Cho Ray Hospital, from August 2013 to September 2018.* ***Results:*** *The average age of the study population was 64.71 ± 11.58. Men accounted for the majority with 62 patients (77.50%). The most common medical history was hypertension (76.25%) and smoking (63.75%), while diabetes was less than 20%. Preoperative tests were mostly within the normal range. The incidence of fusiform aortic aneurysms was lower than that of the saccular aortic aneurysms (38.75% vs. 61.25%, respectively). The average diameter of the TAA was 64.16 mm; its length was 97.92 mm. The mean proximal diameter was 32.00 mm, the mean distal diameter was 26.51 mm. Arterial access size was almost suitable for the endovascular.* ***Conclusion:*** *The average age of TAA patients was over 60 years old, common in men. The common risk factors associated with TAA were hypertension and smoking. The saccular aortic aneurysm was dominant.*

** Keywords: Clinical and subclinical features; Thoracic aortic aneurysm; Endovascular repair.*

INTRODUCTION

The aortic aneurysm is the second most common disease of the aorta after atherosclerosis. In global treatment guidelines, aortic aneurysm is divided into the thoracic aortic aneurysm and abdominal aortic aneurysm because of differences in screening, diagnosis, and treatment strategy [2]. The mean age of detection of aortic disease was 64.3 years old in the normal population and 56.8 years old in people with a family history of aortic disease [3]. Currently, in the world, in developed countries, endovascular repair to treat thoracic aortic aneurysm has been performed many times and is the preferred treatment method compared to conventional open surgery. In Vietnam, many large medical establishments implement endovascular repair to treat TAA. This study aims to: *Describe some clinical and subclinical characteristics of patients with TAA before endovascular repair.*

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SUBJECTS AND METHODS

1. Subjects

Patients with TAA were treated by endovascular under the guidance of DSA or C-arm at Cho Ray Hospital from August 2013 to September 2018.

** Selection criteria:*

- The patients diagnosed with a thoracic aortic aneurysm were indicated for endovascular repair according to the guidelines of the European Heart Association (2014) [2].

- Thoracic aortic aneurysm treated by endovascular.

- Aortic arch debranching surgery and later endovascular repair.

** Exclusion criteria:*

- Combined aortic root aneurysm or ascending aortic aneurysm.

- Combined heart surgery: Heart valve surgery, coronary artery bypass surgery.

- The femoral and pelvic artery morphology is not suitable for endovascular repair.

- Combined abdominal aortic aneurysm.

- Malignancy or severe medical disease with a survival prognosis of fewer than 2 years.

- Allergy to radiocontrast.

- Combined aortic dissection.

2. Methods

** Study design:* Descriptive study on clinical and subclinical characteristics of patients with thoracic aortic aneurysm.

** Sample size:*

The sample size is calculated using the following formula:

$$n = Z^2_{(1-\frac{\alpha}{2})} \times \frac{p(1-p)}{d^2}$$

In which, p is the success rate, d is the marginal error, $Z_{(1-\alpha/2)}$ is the probability of the normal distribution at the error probability α.

- The probability of error $\alpha = 0.05$ then $Z_{(1-\alpha/2)} = 1.96$.

- According to Grace Wang et al, the mortality rate of the TEVAR program in patients with TAA was about 1.9 to 3.1%, an average of 2.5% [11]. So we chose p = 0.025.

- d: Accuracy (or permissible error), choose d = 0.04.

From the above formula, we calculate n = 58.5. Thus, the minimum sample size for the study was 59 patients. In fact, we studied 80 patients.

** Research indicators:*

- Age: The average age and distributed by age groups (under 50, 50 - 59, 60 - 69, 70 - 79 and from 80 years old and over).

- Gender: Male, female, male/female ratio.

- Medical history: Hypertension, diabetes mellitus, coronary artery disease with or without stenting, chronic renal failure, stroke, smoking, dyslipidemia, family history of arterial disease.

- Subclinical tests: Plain chest radiograph, electrocardiogram, echocardiogram, ultrasound of carotid artery.

- Measureparameters of aneurysms on thoracic computed tomography: The shape of an aneurysm (fusiform or saccular); the largest diameter of the aneurysm, the proximal and distal diameter of the aneurysm (mm); the length of the aneurysm (mm); The distance from the aneurysm to the arteries such as left subclavian artery, left common carotid artery, brachiocephalic trunk, celiac trunk (mm); common iliac artery diameter (mm); external iliac artery diameter (mm); common femoral artery diameter (mm).

* *Statistical analysis:* Collected data were entered and processed on the biomedical statistical software SPSS 22.0.

RESULTS

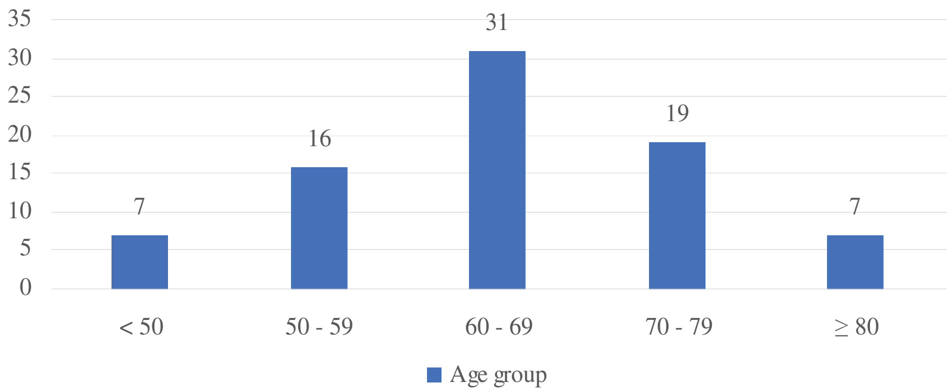

Figure 1: Distribution of patients by age group.

The average age of the study group was 64.71 ± 11.58 years; the youngest 31 years old and the oldest 87 years old. When distributing patients into different age groups, we found that the age group 60 - 69 accounted for the highest proportion (38.75%), the 70 - 79 age group explained for 23.75%, and the age group under 50 years and the elderly group over 80 years old had an equal percentage of 8.75 (7 patients each group).

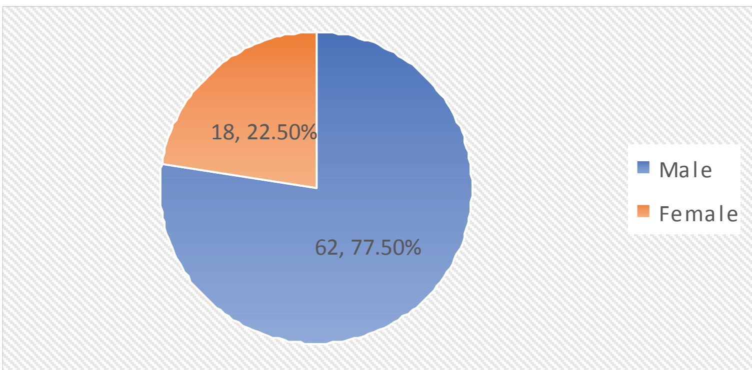

Figure 2: Distribution of patients by sex.

Regarding the sex distribution, in the study group, men accounted for the majority compared to women, the ratio of male/female was 3.4/1.

Table 1: Medical history and cardiovascular risk factors (n = 80).

Medical history and cardiovascular risk factors	**Number (n)**	**Rate (%)**
Hypertension	61	76.25
Diabetes	10	12.50
Coronary artery disease with stenting	5	6.25
Dyslipidemia	49	61.25
Chronic renal failure	1	1.25
Smoking	51	63.75
Stroke history	4	5.00
Chronic obstructive pulmonary disease	2	2.50
Family history of aortic disease	0	0

Among cardiovascular risk factors, hypertension accounted for the highest rate of 76.25% (61 patients), the second-highest rate of smoking was present in 51 patients (63.75%), dyslipidemia ranked the third with 61.25% of cases. The rate of diabetic patients was 12.50%. Coronary artery disease with stenting occupied 6.25% of cases. Other risk factors such as a history of stroke, chronic obstructive pulmonary disease, carotid stenosis, and a family history of an aortic aneurysm were low.

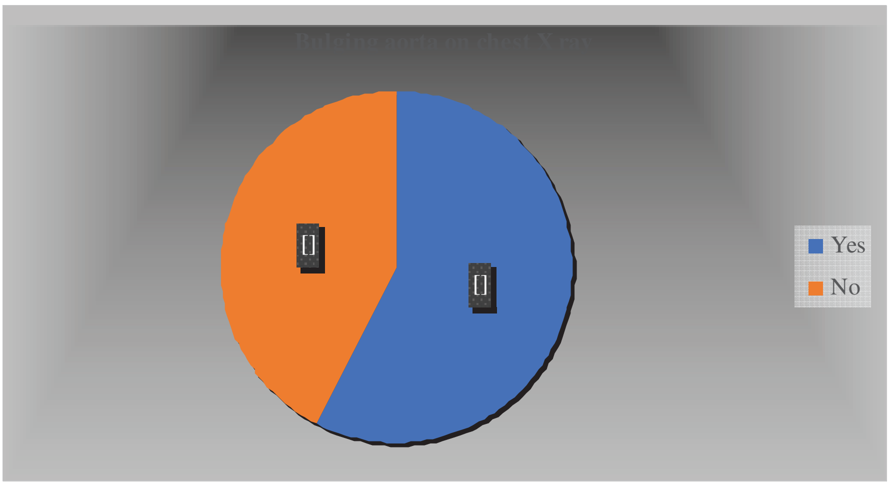

Figure 3: The proportion of bulging aorta on chest X-ray.

There were 46 patients with signs of the bulging aorta on the plain chest X-ray, accounting for 57.50%; and 42.50% of patients did not have this sign.

Table 2: Characteristics of the ECG, echocardiogram and carotid ultrasound.

Characteristics	Value
Echocardiogram	
Mean ejection fraction (%)	65.07 ± 7.29
Abnormal hypoactivity (n, %)	2 (2.5)
ECG	
Heart rhythm - Sinus rhythm (n, %) - Atrial fibrillation (n, %)	 77 (96.25) 3 (3.75)
Myocardial ischemia (n, %)	7 (8.75)

- On the cardiac ultrasound parameters, the average ejection fraction reached 65.07%, the rate of patients with abnormal hypoactivity in cardiac ultrasound was only 2.5%.

- On the electrocardiogram, only 3.75% of patients had atrial fibrillation, the remaining 96.25% were sinus rhythm. 91.25% of patients showed no sign of myocardial ischemia.

Table 3: Characteristics of the superior thoracic aortic aneurysm on computed tomography.

Characteristics	n (%)
Aneurysm shape - Fusiform - Saccular	 31 (38.75) 49 (61.25)
Thrombosis in the wall of an aneurysm - Yes - No	 62 (77.50) 18 (22.50)
Calcification in an aneurysm - Yes - No	 3 (3.75) 77 (96.25)

The rate of the saccular aneurysm was more than that of the fusiform aneurysm. Most of the aneurysms had thrombosis in the wall, with the rate of thrombosis on CT-scans up to 77.50% of cases. 3.75% had calcification into the aneurysm.

Table 4: Dimensional characteristics of the aneurysm and important interventional areas.

Characteristics	Value
The average largest diameter of the aneurysm (mm)	64.16 ± 15.48 (38.0 - 113.0)
The length of the aneurysm (mm)	97.92 ± 65.53 (26.80 - 339.0)
The distance from the aneurysm to the left subclavian artery (mm)	27.63 ± 45.41 (0.0 - 175.60)
The distance from the aneurysm to the left common carotid artery (mm)	40.20 ± 47.87 (0.0 - 196.10)
The distance from the aneurysm to the brachiocephalic trunk (mm)	50.82 ± 48.30 (0.0 - 210.20)
The distance from the aneurysm to the celiac trunk (mm)	141.26 ± 74.93 (5.0 - 256.0)
The proximal diameter of the aneurysm (mm)	32.00 ± 4.60 (21.50 - 40.00)
The distal diameter of the aneurysm (mm)	26.51 ± 4.69 (14.00 - 39.00)

- The average largest diameter of the aneurysm of the patients was 64.16 mm. The length of the aneurysm was 97.92 mm.

- The distances from the aneurysm to the branches of the aortic arch were 27.63 mm, 40.20 mm and 50.82 mm, respectively.

- The proximal diameter of the aneurysm was 32.00 mm. The distal diameter of the aneurysm was 26.51 mm.

DISCUSSION

The average age of our patient group was 64.71 ± 11.58 years old, of which the most common age group was from 60 to 69 years old (38.75%). Male was predominant with male/female ratio of 3.4/1. In the study by Wang et al. in Taiwan, the mean age was 73.3; 78.8% of patients aged ≥ 65 years, and 75.6% of patients were male [10]. With age analysis and male/female ratio, we found that TAA usually occurs in the age group over 60, most frequently in the age group 65 to 70 years and in men 3 to 5 times higher than women. With the above analysis data, the initiation of screening TAA in men over 65 years old can detect and promptly treat this dangerous disease. The methods used to screen for thoracic aneurysms were plain chest radiographs, thoracic echocardiography, and transesophageal echocardiography if indicated.

In terms of the medical history and cardiovascular risk factors, hypertension was high (76.25%), smoking was also an important risk factor in 63.75% of the cases. However, type II diabetes accounted for only 12.50%. Unlike other cardiovascular risk factors, type II diabetes does not increase the risk of aortic aneurysms. In 2019, D'Cruz et al. conducted a study on evaluating the correlation of diabetes and TAA, which included 5 cohort studies and 5 case-control studies with more than 1 million patients selected for analysis. The analysis results of all 10 studies showed an inverse correlation between diabetes mellitus and TAA (OR = 0.77; 95%CI: 0.61 - 0.98). Through this study, the authors concluded that there was an inverse correlation between diabetes mellitus and thoracic aneurysms. In other words, diabetes has the potential to protect patients from aneurysms [1].

In contrast to diabetes, smoking was considered one of the important risk factors for aortic aneurysms. Landenhed et al. conducted a cohort study on evaluating risk factors for aortic disease in a population, including thoracic aortic aneurysm. The study was performed on 30,412 subjects in Sweden, with a follow-up period of 20 years. The authors assessed the incidence of aortic disease, including TAA, and its correlation with risk factors. The results showed that the incidence of the TAA was 9 per 100,000 people-year (95%CI: 6.8 - 12.6). This study showed that smoking increases the risk of developing TAA (HR = 2.2; 95%CI: 1.2 - 4.0), hypertension also increases the risk of developing TAA (HR = 2.2; 95%CI: 1.2 - 4.0), but it was lower than smoking in this study (HR = 1.46; 95%CI: 0.73 - 2.95) [5].

In addition to the above important medical history, other medical histories in our study showed that the patient's risk was quite low, with only 1 case of chronic renal failure, 5 cases of coronary artery disease with stenting, 4 patients of stroke. Therefore, our patient group had a relatively low risk compared with the mean risk in patients with TAA.

On a plain thoracic X-ray, the sign of a bulging aorta arch or enlarged aortic arch is a sign of a thoracic aortic aneurysm. The proportion of patients with enlarged aortic arch in our study was 57.50%. This showed that the specificity of this sign on plain chest radiograph was not high and can be difficult to use to eliminate aortic aneurysms. In 2004, Von Kodolitsch et al. did research on evaluating the role of chest radiographs in the diagnosis of acute aortic syndrome. There were 216 patients (143 men, 73 women) recruited in the study. Patients had a plain chest X-ray because of suspected acute aortic syndrome, with the gold standard for evaluation of CT-scan. The results showed that the plain chest radiograph had 64% sensitivity and 86% specificity for aortic disease. Particularly for the aortic aneurysm, the sensitivity of the plain chest radiograph was 61%. The authors concluded that plain thoracic radiograph limited value in the diagnosis of the acute aortic syndrome, in particular lesions involving the ascending thoracic aorta, and recommended replacement of plain chest radiograph by CT-scan to evaluate more accurately [9].

To assess cardiovascular disease associated with aortic aneurysms, we used echocardiography and electrocardiograms. Since coronary artery disease and aortic disease have many common cardiovascular risk factors, screening for coronary artery disease is essential. In our patient group, the rate of abnormal hypoactivity of cardiac wall was only 2.50%, the rest had good contractile heart, with a mean ejection fraction of 65.07%. On the electrocardiogram, only 3.75% of patients had atrial fibrillation and 96.25% of patients with sinus rhythm; 8.75% of patients showed signs of myocardial anemia on the electrocardiogram and 91.25% had no symptoms of myocardial anemia. Thus, with the above data, our subjects had fewer clear signs of ischemic heart disease. However, in 2007, Ferro et al.'s report on the incidence and risk factors of coronary artery disease associated with aortic disease showed inconsistent results. 95 asymptomatic patients with ischemic heart disease (66 men, 33 women, mean age 63 ± 11.8) were evaluated. The patients will have a coronary angiogram and aortic CT-scan to check for the presence of these two diseases. The results showed that the rate of asymptomatic coronary artery stenosis in patients with aortic disease was 63.1%, of which the rate of coronary artery disease associated with thoracic aortic disease was 70%. The two most important risk factors were smoking and dyslipidemia. The authors concluded that coronary artery disease had a high incidence in patients with aortic disease, and recommended careful coronary artery screening in this group of patients [4].

The aneurysm shape is one of the important factors influencing treatment strategy and prognosis. The aortic aneurysm is divided into two main groups of shapes: Fusiform and saccular aneurysms. Fusiform aortic aneurysms are primarily caused by connective tissue disease or atherosclerosis. In contrast, the saccular aortic aneurysm has many different causes: Advanced infection or previous infection, inflammatory diseases such as tuberculosis, syphilis, degeneration, and progression of a trans-arterial ulcer of aorta, a medical history of aortic injury, Behcet's disease, and Takayasu's disease… [6]. In terms of frequency of occurrence, the location of the saccular aneurysm is most commonly found in the small curvature of the arch of the aorta and near the origin of the visceral artery. According to the study by Shang et al., out of 322 sac aneurysms, 68.1% were in the descending thoracic aorta, 24.2% in the abdominal aorta, 7.1% in the arch, and 0.6% in the ascending thoracic aneurysm [7]. In our study, there were 49 patients with saccular aneurysms, accounting for 61.25%, more dominant than fusiform aneurysms. This is consistent with the above authors because we evaluate the group of patients with TAA, so the saccular aneurysm is more common.

Average length of aneurysm in our study was 97.92 mm if adding the proximal and distal regions (minimum 20 mm per region). The average required intravascular graft length was 138 mm. The thoracic aortic endovascular grafts used in our study had a minimum length of 150 mm, so with the above-average length, normally just one graft can be used to achieve the purpose to isolate the aneurysm with hypovolemic areas with long enough distance to ensure that there were no intravascular leakage complications for the patient. However, there were also cases with the length of the large aneurysm, which need to place many grafting tubes, or the proximal neck and distal neck diameters of the aneurysm were much different, so it needs to place the grafting abide by technique from the bottom up. This technique is performed by placing a smaller size graft in the bottom place first, then placing the larger size within the smaller graft. In this procedure, the hypovolemic areas with a diameter difference of more than 6 mm to 8 mm can be successfully interfered with by the endovascular repair method.

In our study, the average distance from the aneurysm to the main arteries of the aortic arch was: Left subclavian artery (27.63 mm), the left common carotid artery (40.20 mm), and the brachiocephalic trunk (50.82 mm). Thus, with the above-average distances, the proximal and distal landing zones were ensured without the need to aortic arch debranching surgery. However, 43 patients in the study underwent aortic arch debranching surgery. Considering the median number, the distance from the aneurysm to the main arteries of the aortic arch were: 0 mm of the left subclavian artery; the left common carotid artery (19.1 mm); the brachiocephalic trunk (30 mm). In this case, the median in the case of the objective evaluation was more than the mean because in some cases, the distance from the aneurysm was much larger than the others and interfered with the mean.

The mean diameters of the proximal and distal landing zones were 32.00 mm and 26.51 mm, respectively, which were within the current permissible limits for the types of stent grafts used in the research. With TAA, the recommended oversizing of landing zones was 10 to 20%. This rate of the oversizing of endovascular repair in the treatment of TAA has been reported by several authors. Tolenaar et al. performed a meta-study to evaluate the effect of oversizing on the outcome of TEVAR in patients with TAA. The study included four clinical trials with 377 patients (222 male patients, mean age of 72 years). The average oversizing rate was 14.6%. Patients were divided into three groups based on the rate of oversizing: < 10% (n = 85), 10 - 20% (n = 188), > 20% (n = 64). The results showed that aneurysm diameter (32.6 mm vs. 31.3 mm and 28.2 mm, p < 0.001) and aneurysm length in group I (69 mm vs. 58 mm and 52 mm, p = 0.035) were larger than that of the other two groups [8].

CONCLUSION

The average age of the study population was 64.71 ± 11.58. Men accounted for the majority with 62 patients (77.50%). The most common medical history was hypertension (76.25%) and smoking (63.75%), and diabetes was less than 20%. Preoperative tests were mostly within the normal range. The incidence of fusiform aneurysms was lower than that of the saccular aneurysm (38.75% and 61.25%) of the aorta. The average diameter of the aneurysm was 64.16 mm; its length was 97.92 mm. The mean proximal diameter was 32.00 mm and the mean distal diameter was 26.51 mm. Arterial access size of the study group was almost suitable for the endovascular.

REFERENCES

1. Reuban T D'cruz, Ian JY Wee, Nicholas L Syn, et al. The association between diabetes and TAA. J Journal of Vascular Surgery 2019; 69(1):263-268. e1.

2. Raimund Erbel, Victor Aboyans, Catherine Boileau, et al. ESC guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult the task force for the diagnosis and treatment of aortic diseases of the European Society Of Cardiology (ESC) 2014; 35(41):2873-2926.

3. Zainab Faiza, Tariq Sharman. Thoracic aorta aneurysm. J StatPearls 2020.

4. Carlos Romério Costa Ferro, Dinaldo Cavalcanti de Oliveira, Fábio de Freitas Guimarães Guerra, et al. Prevalence and risk factors for combined coronary artery disease and aortic aneurysm. J Arquivos Brasileiros De Cardiologia 2007; 88(1):40-44.

5. Maya Landenhed, Gunnar Engström, Anders Gottsäter, et al. Risk profiles for aortic dissection and ruptured or surgically treated aneurysms: A prospective cohort study. Journal of the American Heart Association 2015; 4(1):e001513.

6. Ourania Preventza, Joseph Coselli. Saccular aneurysms of the transverse aortic arch: Treatment options available in the endovascular era. AORTA Journal 2015; 3(2):61.

7. Eric K Shang, Derek P Nathan, William W Boonn, et al. A modern experience with saccular aortic aneurysms. Journal of Vascular Surgery 2013; 57(1):84-88.

8. Jip L Tolenaar, Frederik HW Jonker, Frans L Moll, et al. Influence of oversizing on outcome in thoracic endovascular aortic repair. Journal of Endovascular Therapy 2013; 20(6):738-745.

9. Yskert Von Kodolitsch, Christoph A Nienaber, Christoph Dieckmann, et al. Chest radiography for the diagnosis of acute aortic syndrome. The American Journal of Medicine 2004; 116(2):73-77.

10. Shih-Wei Wang, Yaw-Bin Huang, Jiann-Woei Huang, et al. Epidemiology, clinical features, and prescribing patterns of aortic aneurysm in Asian population from 2005 to 2011. Journal of Medicine 2015; 94(41).

11. David A Nation, Grace J Wang. TEVAR: Endovascular repair of the thoracic aorta. Seminars in Interventional Radiology 2015; 32:265-271.