Relationship between aortic valve calcification and aortic atherosclerosis: a transoesophageal echocardiography study

Andrzej Wysokiński, Tomasz Zapolski

Chair and Department of Cardiology, F. Skubiszewski Medical University, Lublin, Poland

Abstract

Introduction: Clinical and laboratory data provide an increasing amount of information regarding the common aetiopathogenetic background of acquired heart defects with calcification and arterial atherosclerosis.

Aim: To evaluate the relationship between presence and severity of calcifications of the aortic semilunar valves and the intensity of atherosclerotic lesions in the aorta and aortic stiffness (AS).

Methods: The study group comprised 80 subjects (49 males and 31 females) aged 72.2 (±8.0) years with an aortic valve defect found on echocardiography. Patients were divided into two subgroups depending on the severity of valvular disease. Subgroup I comprised 42 patients with small valvular lesions (0 - absence of calcification of the valve, or + - trivial valvular calcifications, possible to find on detailed evaluation of the valve). Subgroup II consisted of 38 patients with intense calcifications (++ - large, easily found valve calcifications, +++ - massive calcifications affecting leaflet mobility). All patients underwent transoesophageal echocardiography to evaluate atherosclerotic lesions in the aorta. The assessment included the following: location of the lesions in the aorta, intimal thickness, presence of calcifications and mobile parts of plaques and possible associated thrombi. Aortic stiffness was also measured using the formula: $AS=\log (SBP/DBP)/Ao_{max}-Ao_{min})/Ao_{min}$.

Results: Atherosclerotic plaques were more frequent in patients with more prominent calcifications of the aortic valve (19 *vs* 10 patients, $p < 0.05$). Intimal thickness was larger in patients with more pronounced valve calcifications (3.9±0.8 mm *vs* 2.2+0.6 mm, $p < 0.05$). Presence of calcifications in the aortic wall was also more frequent in patients from group II, as they were found in 10 subjects compared to only 3 cases in group I. Mobile plaque parts were observed in 3 patients from group II; also thrombi were found in 3 individuals from this group. Patients with more prominent calcifications of the aortic valve had decreased aortic wall elasticity (AS 5.5±1.2 cm *vs* 3.4±0.9 cm, $p < 0.05$).

Conclusions: Severity of aortic valve calcification indicates simultaneous changes in the thoracic aorta. Stiffness of the aortic wall is greater in patients with a more pronounced defect of the aortic valve. Prevalence of atherosclerosis risk factors is increased in patients with aortic valve defect, enhanced atherosclerosis and rigidity of the aorta. Defect of the aortic valve and increased aortic rigidity may be different manifestations of atherosclerosis.

Key words: aortic valve, aorta, atherosclerosis, calcifications, transoesophageal echocardiography

Kardiol Pol 2006; 64: 694-701

Introduction

Thickening of the aortic valve leaflets and their calcification without impairment of the left ventricular outflow tract flow are commonly observed and in patients over the age of 65 years appear in approximately 25% of cases, whereas significant aortic stenosis is occasionally observed in this age group: 2-7% [1].

It has been shown that changes of the aortic valve are repeatedly associated with coronary artery atherosclerosis [2]. Calcifications of the aortic valve are also connected with severity of atherosclerosis of the carotid arteries

Address for correspondence:
Dr Tomasz Zapolski, Katedra i Klinika Kardiologii AM, SPSK nr 4, ul. Jaczewskiego 8, 20-954 Lublin, Poland, tel: +48 81 724 43 28; fax: +48 81 724 41 51, e-mail: zapolia@wp.pl

Received: 25 January 2006. **Accepted:** 15 March 2006

[3] and other peripheral arteries, particularly the arteries of the lower limbs [4]. It was shown that the prevalence of atherosclerosis risk factors is increased in patients with aortic valve defect compared to the general population [1]. Clinical observations were confirmed by histopathological data where the presence of foam cells (which represent early forms of atherosclerosis) was documented in the endothelium of the coronary arteries and on the aortic surface of semilunar leaflets [5].

Interest in the biochemical features of the aorta and large vessels has increased significantly over the last few years. The aorta is not only the canal for passive distribution of blood from the heart to the periphery but, as documented by more and more studies, it appreciably contributes to the function of the entire vascular system [6]. It performs correctly provided it has the proper elasticity, which is determined by the complex structure of the aortic wall. However, a range of aspects including especially those commonly known as risk factors of atherosclerosis cause increased stiffness of the aorta even prior to clinical evidence of atherosclerosis of other arteries [7]. Increase of aortic stiffness is associated with higher risk of cardiovascular death [8]. A number of noninvasive and invasive methods of evaluation of central and peripheral artery stiffness have been developed [9]. Transoesophageal echocardiography is an important, minimally invasive and accurate method. In addition to the evaluation of aortic elasticity it provides visualization of the intensity of atherosclerotic lesions, including calcifications, thrombi and mobile parts of atherosclerotic plaques.

The aim of the study was to evaluate the relationship between the presence and severity of calcifications of the aortic semilunar valve and the intensity of atherosclerotic lesions in the aorta expressed as morphological abnormalities as well as aortic wall stiffness.

Methods

Patients

The study group comprised 80 subjects (49 males and 31 females) aged 54 to 88 (mean 72.2±8.0) years with an aortic valve defect confirmed on echocardiography.

A detailed medical history of all patients was recorded taking into special account the presence of ischaemic heart disease risk factors: hypertension, lipid metabolism disturbance, diabetes mellitus, smoking, and family history of cardiovascular disease. Furthermore, lipid profile was checked: total cholesterol, LDL-cholesterol, HDL-cholesterol, and triglyceride levels were determined.

Transthoracic echocardiography

Standard transthoracic echocardiography was performed in study groups including measurement of the following parameters: left ventricular end-diastolic diameter (LVEDd), interventricular septum end-diastolic diameter (IVSDd), left ventricular posterior wall end-diastolic diameter (LVPWDd), left atrium diameter (LA), left ventricular ejection fraction (EF), left ventricular shortening fraction (FS), left ventricular stroke volume (SV), left ventricular end-diastolic volume (EDV), maximum aortic valve gradient (Aomax), and magnitude of aortic valve regurgitation (AI). Additionally, the presence of calcifications of the aortic valve was determined:

- 0 – absence of calcification of the aortic valve;
- + – trivial calcifications of the aortic valve, possible to find on detailed evaluation of the valve;
- ++ – large, easily found aortic valve calcifications;
- +++ – massive calcifications affecting aortic leaflet mobility.

Patients were divided into two subgroups depending on the severity of aortic valve disease. Subgroup I comprised 32 patients with small valvular lesions (0 or +). Subgroup II consisted of 28 patients with intense calcifications (++ or +++).

Transoesophageal echocardiography

All patients underwent transoesophageal echocardiography (TEE) to evaluate atherosclerotic lesions in the aorta (Figures 1 and 2). The following parameters were assessed:

- position of the lesions in the aorta (Ao);
- intimal thickness;
- presence of calcifications;
- mobile parts of atherosclerotic plaques;
- presence of thrombi;
- Ao_{max} – maximum diameter of the descending aorta, measured at T-wave peak of simultaneous ECG trace;
- Ao_{max} – minimum diameter of the descending aorta, measured at R-wave peak of simultaneous ECG trace;
- Ao stiffness was calculated using this formula: $AS=\log (SBP/DBP)/Ao_{max}\text{-}Ao_{min})/Ao_{min}$;
- maximum flow velocity in the descending aorta.

Statistical analysis

Results are shown as means ± standard deviation or numbers and percentages. The analysed parameters were compared using Student's t-test. The results were found statistically significant if the p value was less than 0.05.

Results

Clinical evaluation showed that patients with more pronounced calcification of the aortic valve were older,

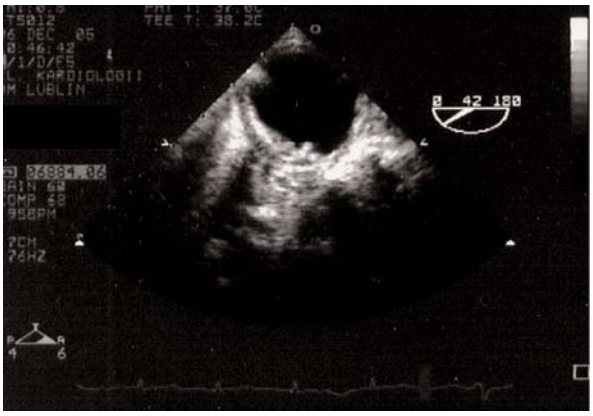

Figure 1. Atherosclerotic plaques in the thoracic aorta on TEE - transverse view

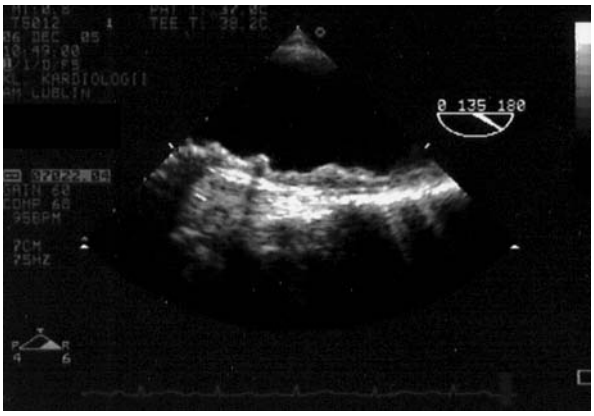

Figure 2. Atherosclerotic plaques in the thoracic aorta on TEE - longitudinal view

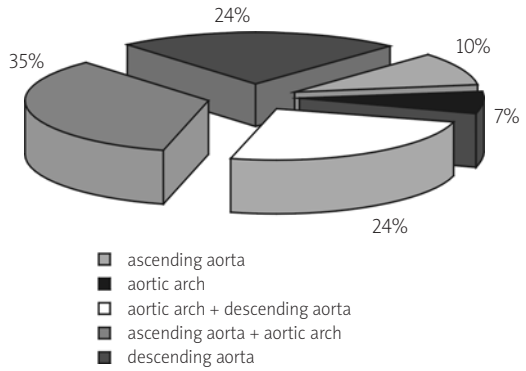

Figure 3. Location of lesions in 29 (100%) patients with known atherosclerotic plaques in the aorta

Table I. Clinical characteristics of the study group in relation to progression of aortic valve calcifications

Risk factor	Patient groups with calcifications		
	small (0 or +) n=42	intense (++ or +++) n=38	p
Age	67.4 (±9.3)	77.5 (±8.9)	<0.05
Males	24 (57.1%)	25 (65.7%)	NS
Hypertension	30 (71.4%)	28 (73.7%)	NS
Smoking	19 (45.2%)	18 (47.3%)	NS
Diabetes mellitus	5 (11.9%)	15 (39.5%)	<0.05
Lipid disturbances	18 (42.8%)	31 (81.6%)	<0.05
Obesity	11 (26.2%)	10 (26.3%)	NS
Family history	8 (19.0%)	8 (21.0%)	NS
Ischaemic heart disease	15 (35.7%)	23 (60.5%)	<0.05
Cerebral stroke/TIA	2 (4.8%)	7 (18.4%)	<0.05

suffered more often from diabetes and had lipid profile disturbances. Moreover, they had more often previously experienced major cardiovascular events and cerebral stroke or transient ischaemic attacks (Table I).

Patients with more severe aortic valve defects had higher left ventricular wall thickness. They also had significantly higher mean and maximum aortic valve gradient and higher grade of aortic regurgitation (Table II).

Atherosclerotic lesions were found in 29 patients. These were primarily located in the aortic arch, descending aorta or in both these segments, whereas location only in the ascending aorta was relatively rare (Figure 3).

Atherosclerotic plaques and calcifications in subjects with more prominent changes within the

Table II. Comparison of echocardiographic parameters in relation to progression of aortic valve lesions

Parameter	Patient groups with calcifications		
	small (0 or +) n=42	intense (++ or +++) n=38	p
LVEDd [cm]	5.1 (±0.9)	5.3 (±0.8)	NS
IVSDd [cm]	1.0 (±0.12)	1.3 (±0.14)	<0.05
PWDd [cm]	0.9 (±0.11)	1.1 (±0.09)	<0.05
EF [%]	60.6 (±7.8)	57.9 (±8.1)	NS
FS [%]	32.3 (±5.6)	30.4 (±6.1)	NS
SV [ml]	88.3 (±21.6)	87.1 (±20.3)	NS
EDV [ml]	148.3 (±34.7)	152.6 (±32.2)	NS
LA [cm]	4.3 (±0.5)	4.4 (±0.6)	NS
Max Ao gradient [mmHg]	7.1 (±0.7)	21.5 (±1.3)	<0.05
Mean Ao gradient [mmHg]	4.5 (±0.5)	12.8 (±1.5)	<0.05
Aortic regurgitation magnitude	0.7 (±0.3)	1.4 (±0.4)	<0.05

Abbreviations: see "Methods" section

Table III. Comparison of patients with more or less prominent lesions of the aortic valve

Parameter	Patient groups with calcifications		
	small (0 or +) n=42	intense (++ or +++) n=38	p
Presence of atherosclerotic plaques in the aorta (number of patients, %)	10 (23.8%)	19 (50%)	<0.05
Presence of calcifications in the aorta (number of patients, %)	3 (7.1%)	10 (26.3%)	<0.05
Mobile parts of plaques (number of patients, %)	0	3 (7.9%)	<0.05
Thrombi (number of patients, %)	0	3 (7.9%)	<0.05

aortic valvular apparatus were significantly more frequent compared to patients with minor valvular changes. Complicated forms of plaques present as mobile parts or thrombi were only observed in patients with significant valve defects (Table III).

Intimal thickness was significantly larger in patients with severe aortic valve defect in comparison to patients with minor valvular disease (Figure 4).

Mean AS index was 4.7 (±1.1). It was significantly higher in patients with more pronounced valve defects (Figure 5).

Comparison of medical history data revealed that patients with less elastic aorta were older, had higher incidence of hypertension and diabetes and more severe lipid profile disturbances. Additionally, a correlation between patients' age and intensity of AS was found (Figure 6).

Medical history data analysis showed that cardiovascular episodes, cerebral strokes or transient ischaemic attacks were more often present in the subgroup with more stiff aorta (Table IV).

Table IV. Clinical characteristics of the study group in relation to grade of aortic stiffness

Risk factor	Aortic stiffness index (AR)		
	Below mean (<4.7±1.1) n=35	Above mean (>4.7±1.1) n=45	p
Age	66.7 (±8.9)	78.4 (±8.6)	<0.05
Males	27 (60.%)	22 (62.8%)	NS
Hypertension	21 (46.6%)	27 (77.1%)	<0.05
Smoking	22 (48.8%)	15 (42.8%)	NS
Diabetes mellitus	4 (8.8%)	16 (45.7%)	<0.05
Lipid disturbances	20 (44.4%)	29 (82.8%)	<0.05
Obesity	13 (28.8%)	8 (22.8%)	NS
Family history	9 (20.0%)	7 (20.0%)	NS
Ischaemic heart disease	14 (31.1%)	24 (68.6%)	<0.05
Cerebral stroke/TIA	2 (4.4%)	7 (20.0%)	<0.05

It was confirmed that patients with larger changes had lower maximum flow velocity within the descending aorta (Figure 7).

Discussion

The results of the study provide evidence that there is a close correlation between nonrheumatic aortic valve disease and the presence of specific atherosclerotic lesions in the aorta and significant unfavourable changes of aortic function.

Our studies showed that the internal aortic layer in patients with calcifications of the aortic valve is notably thicker than in patients with trivial valvular defect. Moreover, the presence of atherosclerotic plaques and calcifications was significantly more frequent in subjects with calcifications of the aortic valvular apparatus. More advanced atherosclerotic lesions such as mobile parts of plaques and thrombi were only observed in patients

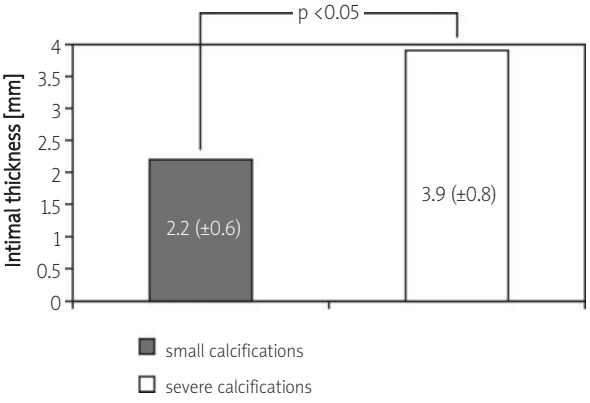

Figure 4. Intimal aortic thickness *vs* severity of aortic valve lesions

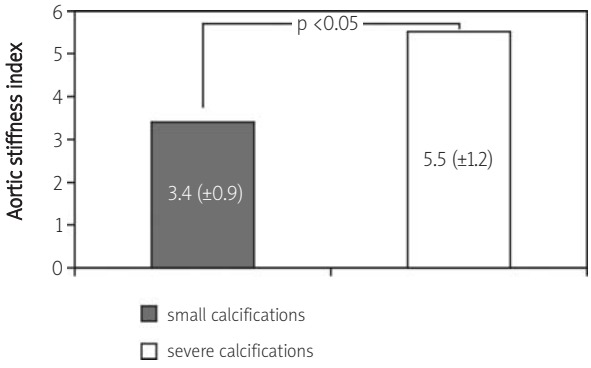

Figure 5. Aortic stiffness index in relation to progression of aortic valve calcifications

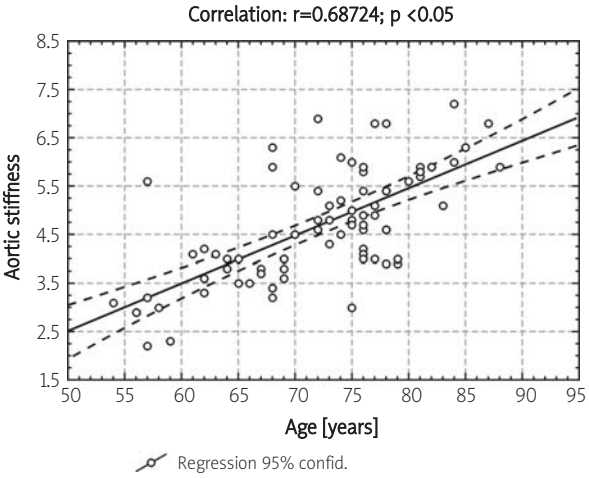

Figure 6. Influence of age on aortic elasticity

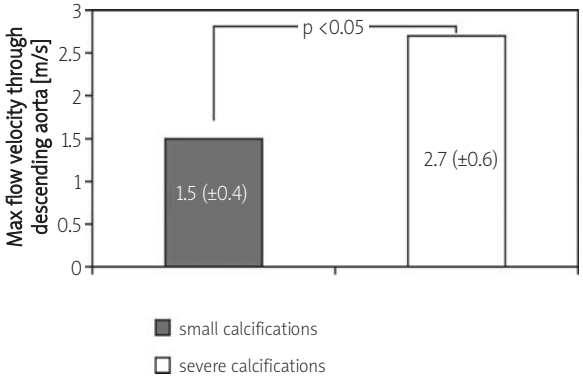

Figure 7. Flow velocity in the descending aorta in relation to progression of aortic valve lesions

with severe destructive changes of the aortic valve. Similar observations were reported by Agmon et al. [10], who showed that patients with more severe aortic valve defects presented more often with atherosclerotic plaques of different thickness and mobile fragments. Furthermore, they found a relationship between plaque thickness and acceleration of flow velocity within the ascending aorta. Compared to the above-mentioned investigations, in our study group more intense lesions were shown in the arch and descending part of the aorta. We also recorded acceleration of flow velocity in the descending aorta in patients with aortic valve defect. However, we did not analyse the flow velocity in the ascending aorta because of possible distortion of results dependent on flow acceleration through the diseased valve. It could influence measurement within the ascending aorta related to the technical aspects of flow velocity calculations using Doppler mode.

The presented relationship between degeneration of the aortic valve and atherosclerotic lesions within the aorta is consistent with relations known so far. Many studies have concluded that aortic valve defect is associated with considerably higher risk of atherosclerosis of various location including coronary arteries [11], carotid and cerebral vessels [12] and inferior limb arteries [13]. On the other hand, a correlation between the presence of atherosclerosis in the thoracic aorta and severity of atherosclerosis in the coronary arteries and carotid artery intima-media complex thickening was established [14].

Morphological abnormalities, although easier to visualise, are not the only manifestation of atherosclerosis. Repeatedly, even with their absence, worsening of the aorta and other arteries' function is observed which is referred to as stiffness. Atherosclerosis is associated with concentric and eccentric thickening of the hyaline layer of arteries and arterioles and impairment of endothelial function, proliferation of smooth muscle cells, and accumulation of lipids and collagen, elastin and proteoglycans [15, 16]. Besides acquired factors also some genetic abnormalities influence the stiffness of large vessels. Medley et al. [17] observed in patients with fibriline 2-3 genotype, which is a protein of the extracellular matrix, higher stiffness of large arteries, higher blood pressure and more severe ischaemic heart disease.

We found in our study group that patients with more severe lesions of the aortic valve had decreased elasticity of the aorta. Stefanadis et al. [18] showed that parameters of elasticity of the aorta were strong and independent risk factors of recurrent acute cardiovascular events. Other studies confirmed the importance of aortic stiffness as an independent risk factor of primary coronary events in patients with arterial hypertension [19]. Consistently, findings of Kinwell et al. [20] highlighted the relationship of impaired elasticity of great vessels with a decrease in the myocardial ischaemic threshold. According to the authors' suggestions it may be caused by the relation between systolic function and myocardial perfusion. Animal studies have shown that pumping blood into a rigid vessel significantly elevates myocardial dysfunction and ischaemia following experimental occlusion of the coronary artery [21]. This phenomenon occurs secondary to the increase of pulse wave velocity which shifts the pressure curve from diastole to the systolic phase. Additionally, the rigid aorta has limited volume while being a reservoir during systolic blood ejection. It is commonly known that myocardial perfusion depends more on diastolic pressure and its duration as well as vascular resistance, and less on the severity of lesions in the arteries. Increase of blood

pressure secondary to enlarged stiffness of great arteries expressed as higher systolic pressure and lower diastolic pressure may, therefore, cause an unfavourable balance between coronary supply and demands.

Our study showed that some commonly recognised risk factors of atherosclerosis were present significantly more often in cases with severe aortic valve lesions. These include age and metabolic factors such as diabetes and hypercholesterolaemia in particular. Moreover, patients with more prominent calcifications of the aortic valve suffered more frequently from serious cardiovascular and cerebrovascular events in the past. This is consistent with previous observations indicating that aortic valve defect appears or progresses along with aging in patients with a negative history of rheumatic heart disease. Concomitant presence with risk factors of coronary artery disease and atherosclerotic lesions in the coronary arteries is also typical [22]. The role of lipid profile abnormalities in the pathogenesis of aortic valve degeneration should be particularly addressed. It was observed that in the defective aortic valve extracellular deposits of neutral fat induce changes of collagen structure in the connective tissue of the valve, with its resultant calcification [23]. Studies of Kawaguchi et al. [24] confirmed that in patients with familial hypercholesterolaemia valvular defects are commonly seen in homozygotes, being rarer in heterozygotes, in whom cholesterol levels are lower. An adverse influence on the progression of the defect was also observed in other studies where patients with cholesterol level above 200 mg% were found to have a stenosis progression rate twice that seen in patients with normal cholesterol concentration [25]. It was confirmed that reduction of aortic valve area in patients without statins in therapy was 0.1 cm per year and only 0.06 cm in subjects taking lipid lowering medications [26].

Clinical analysis with respect to the severity of aortic stiffness revealed that loss of elasticity was more frequent in patients at older age, with arterial hypertension, diabetes and hypercholesterolaemia. Also, we found a correlation between age and aortic stiffness. The presented results show that aortic function may adversely influence many factors. Similarly to patients with advanced lesions of the aortic valvular apparatus, subjects with increased aortic stiffness had ischaemic heart disease and cerebral stroke or TIA in the past. Studies of Stefanadis et al. [27] showed a reverse relationship between aortic elasticity and patients' age and progression of atherosclerosis. It was not surprising that diabetes, one of the major risk factors of atherosclerosis, negatively influenced aortic elasticity. Although the above-mentioned mechanism is an attractive explanation of reduced arterial compliance in diabetes, observations of Oxlunda et al. [28] indicate that changes of vascular elasticity do not depend on the progression of atherosclerosis and are probably caused by other mechanisms.

Airaksinen et al. [29] highlighted the importance of nonenzymatic glycosylation of matrix protein with formation of atypical collagen.

The majority of data suggest that hypercholesterolaemia is associated with the loss of elasticity of the aorta. A model example of this phenomenon is familial hypercholesterolaemia, where a reduction of aortic elasticity is found well before clinical manifestation of atherosclerosis [7, 8]. Implementation of lipid-lowering therapy causes significant reduction of aortic stiffness. Studies of Tomochika et al. [30] documented that more intense and effective lowering of total cholesterol levels from 333 mg% to 219 mg% reduced the aortic stiffness index from 9.88 to 7.88 and also caused partial regression of atherosclerotic lesions. Similarly, two-year therapy with atorvastatin 20 mg daily allowed aortic stiffness to be reduced by 14%. It was accompanied by lowering of the left ventricular mass index and increase of left ventricular ejection fraction, while no significant changes in blood pressure were seen [31]. Also, 3-month but more aggressive treatment with atorvastatin 80 mg daily caused reduction of stiffness of the great arteries and aorta, and it was associated with significant reduction of arterial blood pressure [32]. Long-term treatment with statins reduced expression of matrix metalloproteinase and consequently limited degradation of the aortic wall [33]. Decrease in blood pressure during relatively short-term treatment results most likely from the enhanced production of nitrogen oxide due to stimulation of its synthesis with statins [34] and inhibition of endothelin synthesis, which leads to relaxation of walls of the great vessels [35].

In summary, we may confirm the relationship between degeneration of aortic leaflets and calcification as well as morphological and functional evidence of atherosclerosis. More frequent presence of many common risk factors of atherosclerosis in patients with severe lesions in the valvular apparatus and higher stiffness of the aorta in combination with more numerous, adverse cardiovascular events suggest that two forms of atherosclerosis of various locations may exist. This conclusion along with the published data also gives hope for successful reduction of the incidence of these potentially different diseases.

Conclusions

1. Prominent aortic valve calcifications indicate simultaneous changes in the thoracic aorta.
2. Stiffness of the aortic wall is greater in patients with more severe defect of the aortic valve.

3. Prevalence of atherosclerosis risk factors is increased in patients with aortic valve defect, enhanced atherosclerosis and stiffness of the aorta.
4. Defect of the aortic valve and increased aortic stiffness may be different manifestations of atherosclerosis.

References

1. Stewart BF, Siscovick D, Lind BK, et al. Clinical factors associated with calcific aortic valve disease. Cardiovascular Health Study. *J Am Coll Cardiol* 1997; 29: 630-4.
2. Wysokiński A, Zapolski T, Przegaliński J, et al. Wapniejące nabyte wady zastawkowe a miażdżyca tętnic wieńcowych. *Kardiol Pol* 2004; 61: 156-60.
3. Adler Y, Levinger U, Koren A, et al. Relation of nonobstructive aortic valve calcium to carotid arterial atherosclerosis. *Am J Cardiol* 2000; 86: 1102-5.
4. Aronow WS, Ahn C, Kronzon I. Association of valvular aortic stenosis with symptomatic peripheral arterial disease in older persons. *Am J Cardiol* 2001; 88: 1046-7.
5. Roberts WC. The senile cardiac calcification syndrome. *Am J Cardiol* 1986; 58: 572-4.
6. Boudoulas H, Toutouzas P, Wooley C. Functional abnormalities of the aorta. *Futura*, New York 1996.
7. Pitsavos C, Toutouzas K, Dernellis J, et al. Aortic stiffness in young patients with heterozygous familial hypercholesterolemia. *Am Heart J* 1998; 135: 604-8.
8. Benetos A, Safar M, Rudnichi A, et al. Pulse pressure: a predictor of long-term cardiovascular mortality in a French male population. *Hypertension* 1997; 30: 1410-15.
9. Stefanadis C, Stratos C, Boudoulas H, et al. Distensibility of the ascending aorta: comparison of invasive and non-invasive techniques in healthy men and in men with coronary artery disease. *Eur Heart J* 1990; 11: 990-6.
10. Agmon Y, Khandheria BK, Meissner I, et al. Aortic valve sclerosis and aortic atherosclerosis: different manifestations of the same disease? Insights from a population-based study. *J Am Coll Cardiol* 2001; 38: 827-34.
11. Otto CM, O'Brien KD. Why is there discordance between calcific aortic stenosis and coronary artery disease? *Heart* 2001; 85: 601-2.
12. Adler Y, Levinger U, Koren A, et al. Relation of nonobstructive aortic valve calcium to carotid arterial atherosclerosis. *Am J Cardiol* 2000; 86: 1102-5.
13. Aronow WS, Ahn C, Kronzon I. Association of valvular aortic stenosis with symptomatic peripheral arterial disease in older persons. *Am J Cardiol* 2001; 88: 1046-7.
14. Rohani M, Jogestrand T, Ekberg M, et al. Interrelation between the extent of atherosclerosis in the thoracic aorta, carotid intima-media thickness and the extent of coronary artery disease. *Atherosclerosis* 2005; 179: 311-6.
15. Nabel EG, Selwyn AP, Ganz P. Large coronary arteries in humans are responsive to changing blood flow: an endothelium-dependent mechanism that fails in patients with atherosclerosis. *J Am Coll Cardiol* 1990; 16: 349-56.
16. Ross R, Glomset JA. The pathogenesis of atherosclerosis (second of two parts). *N Engl J Med* 1976; 295: 420-5.
17. Medley TL, Cole TJ, Gatzka CD, et al. Fibrillin-1 genotype is associated with aortic stiffness and disease severity in patients with coronary artery disease. *Circulation* 2002; 105: 810-5.
18. Stefanadis C, Dernellis J, Tsiamis E, et al. Aortic stiffness as a risk factor for recurrent acute coronary events in patients with ischaemic heart disease. *Eur Heart J* 2000; 21: 390-6.
19. Boutouyrie P, Tropeano AI, Asmar R, et al. Aortic stiffness is an independent predictor of primary coronary events in hypertensive patients: a longitudinal study. *Hypertension* 2002; 39: 10-5.
20. Kingwell BA, Waddell TK, Medley TL, et al. Large artery stiffness predicts ischemic threshold in patients with coronary artery disease. *J Am Coll Cardiol* 2002; 40: 773-9.
21. Kass DA, Saeki A, Tunin RS, et al. Adverse influence of systemic vascular stiffening on cardiac dysfunction and adaptation to acute coronary occlusion. *Circulation* 1996; 93: 1533-41.
22. Pohle K, Maffert R, Ropers R, et al. Progression of aortic valve calcification: association with coronary atherosclerosis and cardiovascular risk factors. *Circulation* 2001; 104: 1927-1932.
23. Edwards JE. On the etiology of calcific aortic stenosis. *Circulation* 1962; 26: 17-18.
24. Kawaguchi A, Miyatake K, Yutani C, et al. Characteristic cardiovascular manifestation in homozygous and heterozygous familiar hypercholesterolemia. *Am Heart J* 1999; 137: 410-418.
25. Palta S, Pai AM, Gill KS, et al. New insights into the progression of aortic stenosis – implications for secondary prevention. *Circulation* 2000; 101: 2497-2502.
26. Novaro GM, Tiong IY, Pearce GL, et al. Effect of hydroxymethylglutaryl coenzyme A reductase inhibitors on the progression of calcific aortic stenosis. *Circulation* 2001; 104: 2205-2209.
27. Stefanadis C, Stratos C, Boudoulas H, et al. Distensibility of the ascending aorta: comparison of invasive and non-invasive techniques in the healthy men and coronary artery disease. *Eur Heart J* 1990; 11: 990-996.
28. Oxlund H, Rasmussen LM, Andreassen TT, et al. Increased aortic stiffness in patients with type I (insulin dependent) diabetes mellitus. *Diabetologia* 1989; 32: 7498-752.
29. Airaksinen KE, Salmela PI, Linnaluoto MK, et al. Diminished arterial elasticity in diabetes: association with fluorescent advance glycosylation end products in collagen. *Cardiovasc Res* 1993; 27: 942-945.
30. Tomochika Y, Okuda F, Tanaka N, et al. Improvement of atherosclerosis and stiffness of the thoracic descending aorta with cholesterol-lowering therapies in familial hypercholesterolemia. *Arterioscler Thromb Vasc Biol* 1996; 16: 955-962.
31. Kontopoulos AG, Athyros VG, Pehlivanidis AN, et al. Long-term treatment effect of atorvastatin on aortic stiffness in hypercholesterolemic patients. *Curr Med Res Op* 2003; 19: 22-27.
32. Ferrier KE, Muhlmann MH, Baguet JF, et al. Intensive cholesterol reduction lowers blood pressure and large artery stiffness in isolated systolic hypertension. *J Am Coll Cardiol* 2002; 39: 1020-1025.
33. Aikawa M, Rabkin E, Sugiyama S, et al. An HMG-CoA reductase inhibitor, cerivastatin, suppresses growth of macrophages expressing matrix metalloproteinases and tissue factor in vivo and in vitro. *Circulation* 2001; 103: 276-283.
34. John S, Schlaich M, Langenfeld M, et al. Increased bioavailability of nitric oxide after lipid-lowering therapy in hypercholesterolemic patients: a randomized, placebo-controlled, double-blind study. *Circulation* 1998; 98: 211-216.
35. Hernandez-Perera O, Perez-Sala D, Navarro-Antolin J, et al. Effects of the 3-hydroxy-3-methylglutaryl-CoA reductase inhibitors, atorvastatin and simvastatin, on the expression of endothelin-1 and endothelial nitric oxide synthase in vascular endothelial cells. *J Clin Invest* 1998; 101: 2711-2719.

Zwapnienia zastawki półksiężycowatej aorty a zmiany miażdżycowe w aorcie oceniane przy zastosowaniu echokardiografii przezprzełykowej

Andrzej Wysokiński, Tomasz Zapolski

Katedra i Klinika Kardiologii, Akademia Medyczna im. F. Skubiszewskiego, Lublin

Streszczenie

Wstęp: Dane kliniczne i badania laboratoryjne dostarczają coraz więcej danych za wspólnym tłem etiopatogenetycznym nabytych wapniejących wad serca a miażdżycą tętnic.

Cel: Ocena zależności między obecnością i nasileniem zwapnień zastawki półksiężycowatej aorty a natężeniem zmian miażdżycowych w aorcie oraz sztywnością aorty (SA).

Metodyka: Grupa badana składała się z 80 osób (49 mężczyzn i 31 kobiet) w wieku 72,2 (±8,0) lat, u których w czasie badania echokardiograficznego stwierdzono uszkodzenie zastawki aortalnej. Chorych podzielono na dwie podgrupy w zależności od zaawansowania zmian na zastawce. W podgrupie I znalazło się 42 chorych z niewielkimi zmianami zastawkowymi (0 – całkowity brak zwapnień na zastawce lub + – niewielkie, drobne zwapnienia na zastawce, możliwe do zauważenia przy wnikliwej ocenie zastawki). Podgrupa II liczyła 38 chorych i składała się z chorych z nasilonymi zwapnieniami (++ – duże, łatwo widoczne zwapnienia zastawki, +++ – masywne zwapnienia, powodujące zaburzenia ruchomości płatków). Następnie wszystkim chorym wykonano przezprzełykowe badanie echokardiograficzne w celu oceny zmian miażdżycowych w aorcie. Oceniano lokalizację zmian w aorcie, grubość błony wewnętrznej, obecność zwapnień, a także ruchomych fragmentów blaszek i ewentualnych związanych z nimi skrzeplin. Mierzono także sztywność aorty, którą obliczano wg wzoru SA=log (SBP/DBP)/Ao_{max}-Ao_{min})/Ao_{min}.

Wyniki: Obecność blaszek miażdżycowych była częstsza u chorych z bardziej nasilonymi zwapnieniami zastawki aortalnej (19 pacjentów *vs* 10 pacjentów, p <0,05). Grubość błony wewnętrznej była większa u chorych z nasilonymi zwapnieniami zastawki (3,9±0,8 mm *vs* 2,2±0,6 mm), p <0,05. Obecność zwapnień w ścianie aorty była także częstsza u chorych z grupy II, gdyż stwierdzono je u 10 chorych w porównaniu do grupy I gdzie zaobserwowano je tylko w 3 przypadkach. Ruchome fragmenty blaszek stwierdzono u 3 chorych z grupy II, podobnie skrzepliny stwierdzono u 3 chorych z grupy II. Chorzy z nasilonymi zwapnieniami zastawki aortalnej mieli mniejszą elastyczność ściany aorty (SA odpowiednio 5,5±1,2 cm *vs* 3,4±0,9 cm, p <0,05).

Wnioski: Stopień zwapnienia zastawki półksiężycowatej aorty wskazuje na współistnienie zmian w aorcie piersiowej. Sztywność ściany aorty jest większa u chorych z nasilonym uszkodzeniem zastawki aortalnej. U chorych z uszkodzoną zastawką aortalną, nasiloną miażdżycą i sztywnością aorty większe jest rozpowszechnienie czynników ryzyka miażdżycy. Uszkodzenie zastawki aortalnej oraz zwiększona sztywność aorty mogą być różnymi manifestacjami miażdżycy.

Słowa kluczowe: zastawka półksiężycowata aorty, aorta, miażdżyca, zwapnienia, echokardiografia przezprzełykowa

Kardiol Pol 2006; 64: 694-701

Adres do korespondencji:

dr Tomasz Zapolski, Katedra i Klinika Kardiologii AM, SPSK nr 4, ul. Jaczewskiego 8, 20-954 Lublin, tel: +48 81 724 43 28, faks: +48 81 724 41 51, e-mail: zapolia@wp.pl.

Praca wpłynęła: 25.01.2006. **Zaakceptowana do druku:** 15.03.2006