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Valve Excrescences: Prevalence, Evolution and Risk for Cardioembolism

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Objectives. **We sought to determine prospectively the prevalence, evolution and embolic risk of valve excrescences in normal subjects and patients with and without suspected cardioembolism.**

Background. **Valve excrescences detected by transesophageal echocardiography (TEE) have been considered a cardioembolic substrate in selected patients.**

Methods. **Ninety healthy volunteers (Group I) and 88 patients without suspected cardioembolism and a normal TEE (Group II) were studied and followed up clinically for 58 ± 21 and 48 ± 20 months, respectively. To assess the evolution of valve excrescences, 45 of these subjects underwent repeat TEE at 31 ± 13 months. The findings in Groups I and II were compared with those of Group III—49 patients referred for TEE for suspected cardioembolism.**

Results. **Valve excrescences were detected in 34 subjects (38%) in Group I and in 41 patients (47%) in Group II. In Group III, 20 patients (41%) had excrescences, but 85% of them had other potential cardiac or vascular sources of embolism. In all groups, mitral valve excrescences were predominant (68% to 76%), followed by aortic (38% to 50%) and right-sided valves (<10%). Excrescences were equally frequent in men and women and between all age groups studied. During follow-up in Groups I and II, excrescences persisted unchanged, and 1 (1.4%) of 74 patients with and 2 (2%) of 99 subjects without excrescences had cerebral ischemic events (80% power to detect a clinically meaningful difference of 4%).**

Conclusions. **Valve excrescences are common on the left-sided heart valves of normal subjects and patients regardless of gender and age; they persist unchanged over time and do not appear to be a primary source of cardioembolism.**

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Valve excrescences have been reported with a frequency of up to 22% in patients with suspected cardioembolism referred for transesophageal echocardiography (TEE) (1–4). This finding has led to the hypothesis that they are a substrate for embolism. However, current data are based on studies of patients >60 years old in whom cardiac and vascular diseases and consequently strokes are common. In these groups, it is frequently difficult to define the etiology of strokes as cardioembolic, vasculoembolic or thrombotic (5,6).

If valve excrescences cause cardioembolism, the incidence of systemic embolism in patients with valve excrescences, but no other embolic substrate, should be higher than in those without them. Also, the prevalence of valve excrescences should be higher in patients with compared with those without suspected cardioembolism.

Thus, we designed the present study with two objectives: 1) to determine prospectively the prevalence, evolution and embolic risk of valve excrescences in subjects ≤60 years old with no other embolic substrate on TEE; and 2) to determine the prevalence of valve excrescences in patients with suspected cardioembolism.

Methods

Study groups. From 1989 to 1996 at the Echocardiography Laboratory of the Albuquerque Veterans Affairs Medical Center, a total of 1,352 patients underwent TEE and 454 of them (34%) were ≤60 years old. Of these 454 subjects, 178 (39%) had normal TEE studies—90 were healthy volunteers (Group I) and 88 were patients undergoing TEE for reasons other than suspected cardioembolism (Group II; 73 were also in a study of connective tissue diseases). These subjects underwent TEE as part of prospective studies to assess valve morphology and function (92%) or to exclude aortic dissection or congenital heart disease (8%). For comparisons between Groups I and II, we identified in our computer data base a total of 49 patients referred for suspected cardioembolism (Group III) who were in normal sinus rhythm, had no prosthetic valves and had no suspected infective endocarditis: 35 had a stroke, 10 had transient ischemic attacks and 4 had a peripheral embolism. Echocardiography in Group III was performed 8 ± 9 days (range 0 to 29) after the events. The

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Table 1. Clinical Characteristics of Study Groups*

	Group I (normal subjects [n = 90])	Group II† (SCE absent [n = 88])	Group III‡ (SCE present [n = 49])
Age (yr)			
Mean ± SD	35 ± 8	44 ± 11	63 ± 13
Range	17–57	16–60	34–83
Female	38 (42%)	52 (59%)	7 (14%)
Male	52 (58%)	36 (41%)	42 (86%)
Hypertension	6 (7%)§	18 (20%)	24 (49%)
Diabetes mellitus	0	2 (2%)	11 (22%)
Smoking	10 (11%)	18 (20%)	26 (53%)
Cholesterol >240 mg/dl	0	6 (7%)	15 (31%)
CAD	0	1 (1%)	16 (33%)
PVD	0	0	4 (8%)
Carotid artery disease	0	0	8 (16%)
Aspirin	2 (2%)	9 (10%)	25 (51%)
Warfarin	0	6 (7%)	11 (22%)

*$p < 0.001$ overall between the three groups for each clinical characteristic, except $p = 0.02$ for peripheral vascular disease. †$p < 0.02$ between Group II and Group I for hypertension, smoking, elevated cholesterol and warfarin. ‡$p < 0.001$ for group III versus Group I and Group III versus Group II for hypertension, diabetes, smoking, elevated cholesterol, coronary artery disease, carotid artery disease, aspirin and warfarin, except $p = 0.01$ for peripheral vascular disease. §These patients developed hypertension during follow-up. Data presented are number (%) of subjects, unless otherwise indicated. CAD = coronary artery disease; PVD = peripheral vascular disease; SCE = suspected cardioembolism.

clinical characteristics of the study groups are presented in Table 1.

This study was approved by the Human Research Committee of the University of New Mexico, and all subjects gave written, informed consent.

Echocardiography. All study subjects underwent monoplane (125 studies) or multiplane (102 studies) color Doppler TEE using the model 500, 1500 or 2500 Hewlett-Packard imaging system. In addition to standard views, careful scanning of each heart valve was performed in multiple planes at 4- to 8-cm depth settings and with a narrow sector scan to improve image resolution. In Group III, saline contrast studies and complete evaluation of the thoracic aorta were performed in 57% and 86%, respectively.

The echocardiograms of the three groups were randomly intermixed and interpreted independently by two observers who were unaware of the clinical data. Disagreements were resolved by a third observer.

Criteria for echocardiographic interpretation. *Valve excrescences* were defined as thin (≤2 mm) and elongated (>3 mm) structures with independent, undulating hypermobility seen near the leaflet's line of closure, on the atrial side of the mitral and tricuspid valves and on the ventricular side of the aortic valve. The mitral and tricuspid valve excrescences were measured from the horizontal or longitudinal two-dimensional views during systole and those of the aortic valve from the longitudinal views during diastole. Their maximal length and width were measured and averaged during three cardiac cycles.

To assess intraobserver and interobserver variability in the measurements of length and width of valve excrescences, 30 subjects (13 control subjects and 17 patients) with 37 excrescences (24 mitral, 9 aortic and 4 tricuspid) were randomly selected and remeasured.

Echocardiographically normal hearts were defined as such by standard criteria. Normal valves were those with normal leaflet mobility and thickness (≤3.0 mm mitral and ≤2.0 mm aortic), without calcification and with no more than mild regurgitation assessed by semiquantitative methods (7,8). A valve excrescence was not considered an abnormality. Cardiac sources of embolism were defined by established criteria (9,10).

Clinical and echocardiographic follow-up. In the patients in Group III, all available clinical data (history and physical examination, neurology evaluation, imaging studies of the brain or peripheral arteries and echocardiography) were reviewed to define the etiology of events as: 1) cardioembolic—those with only a cardiac substrate for embolism (excluding valve excrescences); 2) cardiac or vasculoembolic—those with cardiac and thoracic aorta or carotid atheromatous disease; 3) vasculoembolic—those with only arterial atheromatous disease; 4) nonembolic—those without cardiac or arterial disease (including patients with suspected small-vessel disease, atherothrombosis or vasculitis); and 5) undetermined.

Eighty nine subjects (99%) in Group I and 84 patients (95%) in Group II had a clinical follow-up of 58 ± 21 months or 430 person-years and 48 ± 20 months or 336 person-years, respectively, to determine the incidence of systemic embolism by chart review and personal or telephone interview. Presuming a 1% rate per year of systemic embolism in the general population and 5% in subjects with valve excrescences (based on a published odds ratio of 5) (2), a follow-up of 248 person-years was necessary for 80% power and alpha 0.05.

To determine whether valve excrescences persist, resolve or appear again over time, 45 subjects in Groups I and II (32 with and 13 without excrescences) underwent a follow-up TEE 31 ± 13 (range 6 to 68) months later.

Correlation with antiphospholipid antibodies. Antiphospholipid antibodies are associated with increased thrombogenesis, and valve excrescences are thought to have a thrombotic pathogenesis (1,2,11,12). Because this hypothesis would be best tested in a population with a high prevalence of antibodies (i.e., patients with connective tissue diseases), IgG and IgM anticardiolipin antibodies were measured at the time of initial TEE in 47 of the 73 patients with connective tissue disease in Group II. If we presume an association of excrescences and antiphospholipid antibodies with an odds ratio of 3, a sample size of 38 patients in Group II would be needed for 80% power and alpha 0.05. We also measured antibodies in 28 subjects in Group I, but because the prevalence of antiphospholipid antibodies is low (<8%) in normal subjects (11), the lack of an association can only be determined if they have a high prevalence of excrescences. The anticardiolipin antibodies were measured by an enzyme-linked immunosorbent assay method

Table 2. Prevalence and Distribution of Valve Excrescences Within Groups

	Group I (n = 90)	Group II (n = 88)	Group III (n = 49)
Prevalence	34 (38%)	41 (47%)	20 (41%)
Distribution by gender			
Female	13/38 (34%)	23/52 (44%)	2/7 (29%)
Male	21/52 (40%)	18/36 (50%)	18/42 (43%)
Distribution by valve			
Mitral*	26 (76%)	28 (68%)	15 (75%)
Aortic	13 (38%)	18 (44%)	10 (50%)
Tricuspid	2 (6%)	4 (10%)	0
Pulmonic	0	1 (2%)	0
>1 valve	6 (18%)	10 (24%)	5 (25%)

*$p < 0.001$ for subjects with mitral valve excrescences compared with those with excrescences on other valves between the three groups. $p = 0.002$, 0.01 and 0.02 for Groups I, II and III, respectively. Data presented are number (%) of subjects.

(13). The IgG and IgM antibodies were considered present when >8 and >10 IU, respectively, were detected.

Statistical analysis. The Fisher exact test and McNemar test were used for comparison of unpaired and paired binary variables, respectively. The Student *t* test and paired *t* test were used to compare unpaired and paired continuous variables, respectively. Two-way analysis of variance was used for comparison of the length and width of excrescences between valves and groups. One sample binomial test was used for comparison of prevalence rates of valve excrescences. A p value <0.05 was considered significant.

Results

Characteristics of valve excrescences. *Prevalence and distribution (Table 2).* The prevalence of valve excrescences was similarly high in the three study groups: 38% in Group I, 47% in Group II and 41% in Group III. The excrescences were equally frequent among women and men and between the different age groups: 20 to 30 years (29%); 31 to 40 years (46%); 41 to 50 years (48%); 51 to 60 years (37%); 61 to 70 years (33%); and 71 to 80 years (56%). Excrescences were almost exclusively seen on the left-sided valves (92%) and predominantly on the mitral valve (68% to 76%).

The prevalence of valve excrescences was unrelated to aspirin or warfarin therapy. In Group II, 8 (53%) of 15 patients taking either therapy and 33 (45%) of 73 patients taking neither drug had valve excrescences. Similarly, in Group III, 14 (42%) of 33 patients with therapy and 6 (38%) of 16 without therapy had valve excrescences.

Length and width. Excrescences generally measured 5 to 10 mm in length (range 4 to 16) and 1 mm in width (range 0.6 to 2) (Table 3) (Fig. 1 and 2).

Leaflet and chamber location. All but six excrescences were seen at or very near the leaflets coaptation point, on the atrial side during systole for the mitral (Fig. 1) and tricuspid valves and in the outflow tract during diastole for the aortic valve (Fig. 2). Four aortic valve excrescences were also noted on the vessel side during systole.

Multivalvular involvement and association with valve regurgitation. Excrescences were seen on more than one valve in 18% of Group I, in 24% of Group II and in 25% of Group III. In 11 (5%) of the total 227 study subjects, more than one excrescence per valve was noted. In Groups I and II, ≤7% of valves with and ≤5% without excrescences had mild regurgitation. The rest had none or trivial regurgitation.

Evolution. Valve excrescences (23 mitral, 17 aortic and 3 tricuspid) persisted unchanged on follow-up TEE in the 32 subjects with excrescences on initial TEE. In the other 13 subjects, no excrescences were observed on either study.

Aspirin or warfarin therapy did not appear to have an effect on the evolution of valve excrescences. Of the 32 subjects with persistent valve excrescences, 24 (75%) were taking either therapy between studies and 8 (25%) were not.

Association with antiphospholipid antibodies. The presence or concentration of antiphospholipid antibodies was not associated with the presence of excrescences. Twenty-three (49%) of 47 patients in Group II had IgG or IgM anticardiolipin antibodies. Thirteen (56%) of 23 patients with and 10 (44%) of 24 without excrescences had antibodies. The concentration of IgG and IgM anticardiolipin antibodies was also similar in subjects with (47 ± 28 and 24 ± 20 IU, respectively) or without excrescences (43 ± 36 and 28 ± 21 IU, respectively). In Group I, 12 (48%) of 25 subjects without antibodies had excrescences.

Cardioembolic risk. In Groups I and II, 1 (1.4%) of 74 subjects with and 2 (2%) of 99 without excrescences had

Table 3. Length and Width of Valve Excrescences

	Group I		Group II		Group III	
Valve	Length	Width	Length	Width	Length	Width
Mitral (mm)	8.3 ± 2.4*	1.3 ± 0.4†	8.1 ± 2.8	1.0 ± 0.3	9.0 ± 2	1.1 ± 0.2
Aortic (mm)	7.0 ± 2	1.1 ± 0.14	8.1 ± 3	1.2 ± 0.4	7.0 ± 1.2	1.2 ± 0.2
Tricuspid (mm)‡	7.3 ± 2.5	1.25 ± 0.2	8.4 ± 2.6	1.0 ± 0.1	—	—

*$p = 0.047$ for the length of mitral versus aortic valve excrescences, on average, between the three groups. In two-way analysis of variance, the average of the three groups was used because the difference in the mean values in each group was not different ($p = 0.13$). †$p = 0.03$ for the interaction between the three groups, indicating a wider width of mitral versus aortic excrescences in Group I but a narrower width in Groups II and III. ‡Because tricuspid valve excrescences were rare, they were not included in the analysis. Data presented are mean value ± SD.

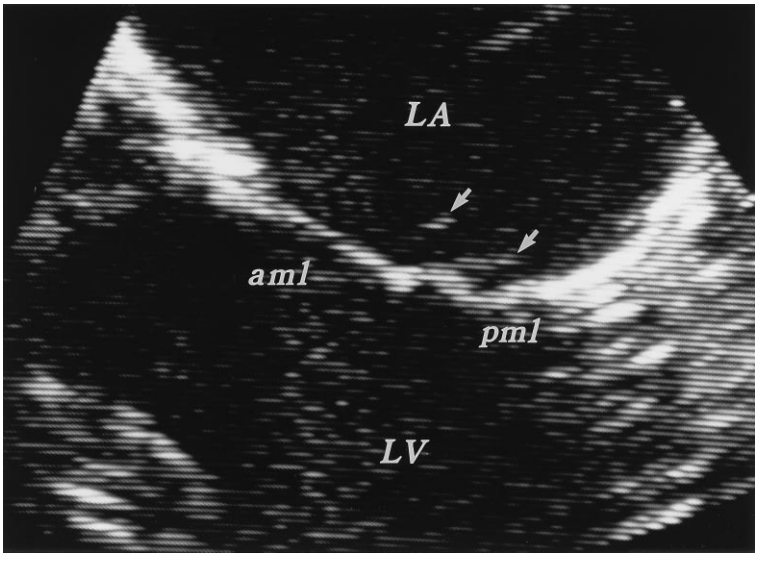
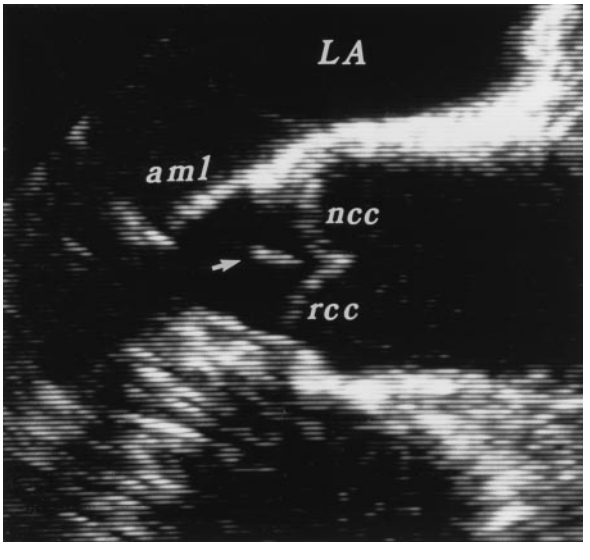


Figure 1. Mitral valve excrescences in a normal 32-year old man. This TEE closeup view of the mitral valve demonstrates two valve excrescences **(arrows)** prolapsing during systole into the left atrium (LA) from the coaptation point of the anterior (aml) and posterior (pml) mitral leaflet. LV = left ventricle.

cerebral ischemic events during a follow-up period of 53 ± 22 months or 330 person-years and 53 ± 20 months or 436 person-years, respectively (0.3% and 0.46% person-years, respectively). The patient with an excrescence was a 26-year old woman with systemic lupus erythematosus and hypertension in whom a Libman-Sacks vegetation and a persistent excrescence were seen on follow-up TEE.

Although 20 (41%) of the 49 patients in Group III had excrescences, 85% of them had other cardiac or vascular sources of embolism (Table 4). Also, the prevalence of excrescences was similar among patients with cardiac, vascular or nonembolic events (Table 5).

Figure 2. Aortic valve excrescence in a 58-year old man. This TEE longitudinal view of the aortic valve demonstrates a valve excrescence **(arrow)** prolapsing during diastole into the outflow tract from the coaptation point of the non (ncc) and right (rcc) or left coronary cusp. aml = anterior mitral leaflet.



Variability of measurement of valve excrescences. For one observer, repeated measurements of 37 valve excrescences showed a variability of up to 1.4 mm in length and 0.3 mm in width. Between two observers, the variability was up to 1 mm and 0.4 mm, respectively.

Discussion

Major findings. There are four important results of this study. Valve excrescences 1) are common on the left heart valves; 2) have a similar prevalence in normal subjects and in patients with or without suspected cardioembolism regardless of age and gender; 3) persist unchanged over time; and 4) do not appear to be associated with future embolic events.

Comparison with postmortem studies. In 1856, Lambl (14) first described small filiform processes on the ventricular

Table 4. Embolic Substrate in Patients With Suspected Cardioembolism

Embolic Substrate	Excrescences Present (n = 20)	Excrescences Absent (n = 29)
LA pseudocontrast	0	5 (17%)
Patent foramen ovale	2/10* (20%)	2/16* (13%)
IA septal aneurysm	3 (15%)	1 (3%)
Valve disease	8 (40%)	7 (24%)
Low LV ejection fraction	2 (10%)	7 (24%)
Abnormal wall motion	1 (5%)	8 (28%)
LV thrombi	0	1 (3%)
LV aneurysm	0	2 (7%)
Aortic atheroma	10/20* (50%)†	3/22* (14%)
Carotid artery disease	5/13* (38%)	3/15* (20%)
Any	17 (85%)‡	16 (55%)

*Denotes number of subjects in whom a saline contrast study, complete evaluation of the aorta and carotid artery studies, were performed. †p = 0.02 and ‡p = 0.03 for subjects with versus those without excrescences. Data presented are number (%) of subjects. IA = interatrial; LA = left atrial; LV = left ventricular.

Table 5. Prevalence of Valve Excrescences by Etiology of Stroke or Embolism

Etiology of Event	Excrescences Present (n = 20)	Excrescences Absent (n = 29)
Cardioembolic	5 (25%)	12 (41%)
Cardiac or vasculoembolic*	7 (35%)	5 (17%)
Vasculoembolic	3 (15%)	0
Nonembolic†	5 (25%)	6 (21%)
Undetermined	0	6 (21%)

*Denotes the presence of cardiac and carotid or aortic atheromatous vessel disease as sources of emboli. †Includes those with cerebral small-vessel disease, atherothrombosis or vasculitis. Data presented are number (%) of subjects.

surface of normal and abnormal aortic valves. In subsequent pathologic series of normal valves, a 70% to 90% prevalence of excrescences was reported, predominantly on the mitral (70% to 85%) and aortic valves (62% to 90%), but also on the right-sided valves (8% to 20%) (15–17). The excrescences are thin (up to 1.5 mm in width) and elongated (up to 10 mm in length), frequently multiple and located on the leaflet's line of closure, on the atrial side of the atrioventricular valves and on the ventricular side of the semilunar valves. They are seen in subjects 1 to 60 years old regardless of gender. Other studies of rheumatic and degenerative valve disease report a prevalence of 20% to 65% (18,19). Valve excrescences consist of a core of connective tissue with collagen and elastic fibrils or of an acellular hyaline material covered by endothelium (15–17). Thus, it seems likely that the excrescences noted in this and previous studies (1–4) correspond to those described by Lambl and other investigators (14–19). Their persistence over time without significant change supports this hypothesis. However, surgical or pathologic studies are needed to confirm this hypothesis.

Etiology. The etiology of valve excrescences is uncertain. The constant bending and buckling of the leaflets may lead to tearing of subendocardial collagen and elastic fibers, which subsequently endothelialize (15–17). This may explain their predominance on the left-sided valves, where the impact of valve closure and shear forces is the highest owing to large pressure differences. The presence of excrescences on normal valves early in life and their similar prevalence in different age groups suggest that they may not result from an injury or age-related process. Finally, the lack of an association between antiphospholipid antibodies and aspirin or warfarin therapy does not support a relation to a hypercoagulable state.

Comparison with previous echocardiographic studies. In this study, a higher prevalence (42%) of excrescences than that reported in previous series (≤22%) (1–4) was observed. Mitral and aortic valve excrescences were common, but they were also seen on the right-sided valves. Previous studies have described them almost exclusively on the mitral (1,4) and rarely on the aortic valve (2,3). Differences in methods may explain these discrepant results. In this study, echocardiography was performed and interpreted with emphasis on the assessment of valve morphology, including the presence of valve excrescences. In previous series, echocardiography was performed for identification of a cardioembolic substrate. This study included excrescences with a width of ≤2 mm, as compared with a recent series that included only those with a width of ≤1 mm (2). Compared with previous series that have used mostly monoplane or biplane TEE, we used multiplane TEE in 45% of subjects.

Valve excrescences as a cardioembolic substrate. In this study of subjects with a high prevalence of valve excrescences, the incidence of cerebrovascular ischemic events was low (<0.5 per 100 person-years) and similar to that of those without excrescences. Also, the prevalence of excrescences was similar in patients with and without embolic events. These findings support the view that excrescences are neither a primary pathogenetic factor nor a marker for embolism. Previous studies suggesting their cardioembolic potential have several limitations. Lee et al. (1) detected mitral valve excrescences in 11 (22%) of 50 patients with suspected cardioembolism. However, these patients were at a moderate or high risk of stroke from other causes. Nine of the 11 patients had valve thickening or calcification and seven had a history of arrhythmias, myocardial infarction, cardiomyopathy or hypertension. Despite presumed embolic events, 24 of the 50 patients had neither cardiac abnormalities nor valve excrescences. Also, the mean age of the patients was 63 years and no mention was made of the appearance of the aorta. Freedberg et al. (2), in a retrospective analysis of 1,559 patients with a mean age of 66 years, identified valve excrescences in 86 (5.5%). Of 597 patients with suspected embolism, 63 (10.6%) had excrescences, as compared with 23 (2.3%) of 962 without emboli. In 41 patients with valve excrescences but no other embolic substrate, 33 (83%) had suspected embolism, as compared with 12 (29%) of 41 case control subjects. Similarly, in their group, stroke risk was high. They studied an elderly group of patients, and >10% had prosthetic or abnormal native valves. These factors may have contributed to their group's high prevalence of suspected cardioembolism (38%) and to skewing of the results toward an association with excrescences. Preliminary retrospective data in another series had similar limitations (4).

Thus, currently available data have not clearly demonstrated that valve excrescences are a source of embolism and our data suggest they are not.

Differentiation from infective and noninfective valve masses. Suspected cardioembolism and infective endocarditis are among the most common indications for TEE (20). Infective vegetations have a valve distribution, leaflet and chamber location and mobility similar to those of valve excrescences. Although infective vegetations are generally >3 mm in diameter, in patients with suspected endocarditis, it may be difficult to differentiate a small or an early infective mass from an excrescence. In this setting, an infective vegetation, in contrast to an excrescence, may resolve or change in appearance over

time (21). Interestingly, many TEE series in infective endocarditis have not reported valve excrescences as a cause of false positive studies (22–24).

Libman-Sacks and thrombotic vegetations, in contrast to valve excrescences, are located on any leaflet portion, are generally rounded and sessile, measure >3 mm in diameter, have heterogeneous echoreflectance and have no independent mobility (25–27).

Valve excrescences are echocardiographically distinct from ruptured chordae tendineae. Ruptured chordae tendineae are generally >3 mm thick and associated with prolapse of the respective leaflet, and usually the valve has myxomatous thickening and significant eccentric regurgitation (28,29).

Study limitations. The lack of pathologic confirmation limits conclusions about the nature of valve excrescences seen on TEE. The prevalence of valve excrescences found in this study group may differ from that of a general population. However, the prevalence of excrescences in healthy subjects was similar to that of two different patient groups. A larger population with longer follow-up is necessary to better assess the true prevalence and embolic risk of valve excrescences. An association of excrescences with a hypercoagulable state cannot be excluded because other variables of hypercoagulability were not tested. However, aspirin or warfarin therapy did not appear to have an effect on the prevalence and evolution of valve excrescences. Also, the high prevalence of excrescences in healthy subjects and the lack of thromboembolic manifestations during follow-up make this association less likely.

Clinical implications. The results of this study have several important clinical implications. The data are in agreement with postmortem series establishing that valve excrescences are frequent in subjects of any age or gender, with or without heart disease, and are probably of no pathophysiologic significance. Thus, the finding of valve excrescences in a patient with suspected cardioembolism should not be considered the likely cause of the event, and other noncardiac causes of stroke or embolism should be investigated before recommending anticoagulant therapy.

Patients with suspected cardioembolism and a normal transthoracic echocardiogram should not routinely undergo TEE for the detection of valve excrescences. In these patients, clinical and transthoracic echocardiographic data predict the absence on TEE of a cardioembolic substrate in 95% of patients (3). The detection of valve excrescences by TEE not only does not establish a causal relation with embolism, but also may not alter therapy.

In patients who undergo TEE for reasons other than suspected cardioembolism, the incidental finding of a valve excrescence probably does not warrant the prophylactic use of antiplatelet therapy. Finally, an awareness of the high prevalence and distinctive characteristics of valve excrescences may improve the diagnostic accuracy of TEE for infective and noninfective valve masses.

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