Valve Strands Are Strongly Associated With Systemic Embolization:
A Transesophageal Echocardiographic Study

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Objectives. We attempted to determine the prevalence of strands on native and prosthetic valves, as detected by transesophageal echocardiography, and to assess the relative risk for systemic emboli associated with these strands.

Background. Fine threadlike strands, seen on native and prosthetic valves by transesophageal echocardiography, have been implicated in systemic embolization.

Methods. During a 2-year period, 1,559 patients underwent transesophageal echocardiography at our center. Of these, 41 patients had strands and no other identifiable source of systemic emboli. They were matched for age, gender, history of hypertension and history of smoking with a control group of 41 patients without strands who also had no identifiable source of emboli. The risk of embolization in the two groups was compared.

Results. Of 1,559 patients studied by transesophageal echocardiography, 86 (5.5%) had strands. Strands were far more common on mitral valves than on aortic valves. Of the patients with strands, 38% had had an event consistent with a systemic embolus, whereas 62% had not. Of 597 patients with an embolic event, 63 (10.6%) had strands, whereas only 23 (2.3%) of 962 patients without emboli had strands. In the case-control study, 33 (83%) of the 41 patients with strands without another source of embolism had emboli compared with only 12 (29%) of the 41 control patients without another source (odds ratio 10.0, 95% confidence interval 3.6 to 27.8, p = 0.00001).

Conclusions. Valvular strands visualized by transesophageal echocardiography are associated with systemic embolization.

(J Am Coll Cardiol 1995;26:1709-12)
valve that had a typically myxomatous or rheumatic appearance was automatically classified as "significantly thickened."

Statistical analysis. Nonparametric variables were compared by using the chi-square test, and estimated odds ratios and 95% confidence intervals were calculated. A p value < 0.05 was considered significant.

Results

Overall prevalence of strands. Among 1,559 patients studied by transesophageal echocardiography in our laboratory, strands were identified in 86 (5.5%). The patients ranged in age from 23 to 93 years (mean 66).

Distribution of strands. Among the 86 patients with strands, the strands were located on the mitral valve in 60 (70%), the aortic valve in 23 (27%) and both left heart valves in 3 (3%).

Morphology of valves with strands. Of the 89 valves with strands, 79 (89%) were either morphologically normal or minimally thickened native valves, 7 (8%) were significantly thickened native valves and 3 (3%) were mechanical prostheses. There were no porcine prostheses with strands.

Prevalence of strands in patients with and without an embolic event. Of the 1,559 patients studied by transesophageal echocardiography, 597 (38%) had had an event that, on clinical grounds, was consistent with a systemic embolus. Other potential sources were defined as a history of atrial fibrillation, presence of intracardiac clot or spontaneous echo contrast, patent foramen ovale or atrial septal defect, aortic atheroma or carotid artery disease (determined by carotid duplex ultrasonography, contrast angiography or magnetic resonance angiography).

The 41 patients with no other embolic source formed the study group. They were randomly matched for age, gender, history of hypertension and history of smoking with 41 other patients without strands on transesophageal echocardiography who also had no identifiable source of emboli. The latter 41 patients served as the control group.

There was no significant difference between the two groups with respect to the presence of a prosthetic valve (four patients with strands vs. seven control patients, p = NS) or the use of anticoagulant or antiplatelet therapy (22 patients with strands vs. 22 control subjects, p = NS).

Of the 41 patients with strands, 33 (83%) had emboli; of the 41 control patients, only 12 (29%) had emboli (odds ratio 10.0, 95% CI 3.6 to 27.8, p = 0.00001) (Fig. 2).

Identification of strands. To assess interobserver variability and to ascertain whether there was any observational bias with regard to the detection of strands, the transesophageal echocardiograms of the 82 patients in the retrospective case-control study were reviewed a second time by two echocardiographers who had no knowledge of the clinical indications for the studies or the previously determined results.

Of the 164 valves seen a second time by one of two echocardiographers, 4 valves initially thought to bear strands were interpreted as not having strands, and 4 valves initially thought not to bear strands were interpreted as having strands on the second reading. With the four false positive results (2.4%) and four false negative results (2.4%), concordance with the original interpretation was 95% for the 164 valves and 91% for the 82 patients (1 patient had 2 valves that were read discordantly).

Of these 82 studies, 78% were performed with biplane...
transducers and 22% with omniplane transducers. The zoom modality was used in 40% of the studies. However, in only two cases did the zoom permit visualization of strands that were not seen without zoom.

**Discussion**

**Preponderance of mitral valve involvement.** In our series, as in others, valvular strands were more commonly seen on mitral than on aortic valves. This echocardiographic observation may, in part, be due to the close proximity of the mitral valve to the transesophageal transducer, and hence to the superior resolution of the mitral valve and its paravalvular structures. Alternatively, it may reflect a real anatomic difference between mitral and aortic valves and divergent propensities for strand formation.

**Association of strands with emboli.** There was a highly significant difference in the prevalence of strands in patients studied by transesophageal echocardiography because of an embolic event versus that in patients studied for another indication. Although different in degree, the divergent prevalences of strands in these two groups in our study (10.6% in those with an embolic event vs. 2.3% in those without a history of an embolus) parallel those in previous reports. In a prospective series of 50 patients (without significant carotid artery disease and with a nonrevealing transthoracic echocardiogram) studied by transesophageal echocardiography because of a stroke or transient ischemic attack, Lee et al. (8) reported a 22% prevalence of mitral strands. The higher prevalence in their series may reflect their more liberal definition of strands, which included excrescences >1 mm in width. Pearson et al. (9) found mitral strands in 5% of 318 patients with stroke and in only 0.3% of 650 patients not being studied because of an embolus.

By not including patients with torn chordae or flail mitral leaflets, we may have excluded some patients with myxomatous degeneration who had strands but were referred for evaluation of valvular insufficiency and not for emboli. Thus, our exclusion criteria may have led to a greater difference in the prevalences of strands in the groups with and without emboli than would have occurred if these patients had been included. Alternatively, the exclusion of some patients with valvular morphologies that are known to be associated with a higher incidence of cerebrovascular events and possibly a higher incidence of strands (i.e., myxomatous valves), may have led us to underestimate both the overall prevalence of strands in the patients referred for transesophageal echocardiography and, in particular, the prevalence of strands in those referred specifically for evaluation of embolization.

Another possible limitation of our case-control (retrospective) study was the matching of only four variables that may contribute to embolic risk. In addition, the case-control design does not eliminate any possible referral basis.

**Etiology of strands.** The etiology of valvular strands remains unclear. None of our patients with strands underwent cardiac surgery that might have provided pathologic data regarding the composition of strands. Lee et al. (8) described one patient with a thickened mitral valve and strands who underwent valve replacement because of mitral regurgitation. Pathologic examination of the strands attached to the excised valve revealed Lambl's excrescences. Lambl originally described these filamentous processes on the ventricular surface of an aortic valve, but these same excrescences were subsequently described on the atrial surfaces of the atrioventricular valves.

Magarey (10), who studied these excrescences on 250 mitral valves, suggested that they were more common with advanced age. This led him to speculate that they were due to fibrin deposition over damaged endocardial valvular surfaces that subsequently became partially detached from the valve, condensed and hyalinized, and ultimately fibrosed. Fresher fibrin deposits were found to be enmeshed with erythrocytes and leukocytes.

**Relation to valve morphology.** Magarey reported that Lambl's excrescences were more commonly found on thickened valves. This observation is not surprising because valvular thickening (as seen with rheumatic valves) or redundancy (as seen with myxomatous valves) may predispose valves to fissuring of their endothelial surfaces, thus rendering them thrombogenic. Indeed, Lee et al. (8) also suggested that mitral thickening visualized by echocardiography was associated with a higher incidence of mitral valve strands. However, both Magarey (10), in his pathologic description of Lambl's excrescences, and Lee et al. (8), in their series of stroke patients with strands, included valvular excrescences >1 mm in width; in fact, both studies included lesions up to 5 mm in width.

In our series, strands were more common on normal native valves than on valves that were significantly thickened. However, we excluded excrescences >1 mm in width. In addition, it is possible that our exclusion of valves with torn chordae or flail leaflets excluded a few myxomatous or other morphologically abnormal valves that also had strands.

Whether strands on native valves and those on prosthetic valves identified by transesophageal echocardiography represent the same morphologic entity is not clear. However, the greater prevalence of strands on prosthetic valves (12% as assessed by Orsinelli and Pearson [11] and 18% as assessed by Isada et al. [12]) and, in particular, the much greater prevalence on mechanical as opposed to tissue prostheses in both series suggest that strands are related to thrombosis. Stoddard et al. (13), in fact, reported a startling 75% prevalence of strands on St. Jude prostheses in the mitral position.

With both native and prosthetic valves, strands have been reported to be associated with embolization. In the series of Orsinelli and Pearson (11), 69% of patients with prosthetic valves and systemic embolization had prosthetic valve strands in contrast to 12% of patients being studied by transesophageal echocardiography because of prosthetic valve dysfunction. Isada et al. (12) reported on two patients with strands on mechanical prostheses who underwent valve replacement because of recurrent embolization; there was pathologic confirmation of thrombus on both valves.
Potential implications. Whether strands or fragments of strands themselves embolize, or whether they are merely markers for an embolic potential, is not known. The high prevalence of normal valve morphology in our series suggests that they are not simply a marker for valve morphologies that may be associated with platelet aggregation or clot formation. However, they may be a marker of hypercoagulable states that predispose patients to thromboembolic disease, a possibility that deserves further investigation. We are currently studying the prevalence of anticardiolipin antibodies in patients with strands.

Definitive therapy for patients with strands, and particularly for those who have already had an embolic event without another source for embolism, is undetermined. In our case-control study, there was no difference in the use of anticoagulant or antiplatelet therapy in patients with and without strands who had no other identifiable sources of emboli. Orsinelli and Pearson (12) reported on a patient who, with a prothrombin time in the therapeutic range, had a transient ischemic attack and strands on his mitral prosthesis; these strands were no longer seen after the addition of dipyridimole to his regimen. However, such data are anecdotal.

Prospective transesophageal echocardiographic follow-up studies are needed to assess the efficacy of anticoagulant or antiplatelet therapy, or both, in eradicating the finding of strands. In addition, prospective clinical trials are required to determine the efficacy of these approaches in preventing embolization in patients with strands.

References


