Diagnosis of Left Atrial Appendage Thrombi by Multiplane Transesophageal Echocardiography — Interlaboratory Comparative Study —

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Background  Transesophageal echocardiography (TEE) is regarded as the method of choice for imaging left atrial appendage thrombi (LAAT). However, the interobserver variability among 2 independent echocardiographic laboratories in diagnosing LAAT by multiplane TEE has not yet been assessed.

Methods and Results  The videorecordings of 50 patients in atrial fibrillation (25 from each laboratory) were blindly reviewed by 1 experienced observer from each institution. LAAT were assessed as present, absent or questionable. Indications for TEE were: cardioversion (n=17), valve disease (n=13), endocarditis (n=12), or embolism (n=8). The prevalence of LAAT was 10% (observer 1) vs 12% (observer 2). A questionable LAAT was assessed in 6% vs 12% and a LAAT was excluded in 84% vs 76%, respectively. By head-to-head comparison, disagreement occurred in 11 cases (22%, kappa =0.5). Discrepant results were not related to the echocardiographic equipment. Problems occurred because of reverberation artifacts of the ridge between the left atrial appendage and left upper pulmonary vein (n=5), and in differentiating LAAT from spontaneous echocardiographic contrast (n=4) or an echogenic atrioventricular groove (n=1). The differentiation of pectinate muscles from LAAT was the reason for disagreement in only 1 case. Eliminating the category of questionable thrombi increased the kappa value to 0.65. In 5 patients undergoing cardiac surgery, both observers had agreed on the presence (n=1) or absence (n=4) of LAAT, and intraoperatively the results of TEE were confirmed.

Conclusion  Even with multiplane TEE, interobserver variability among 2 independent echocardiographic laboratories for diagnosing LAAT remains high because of problems in differentiating LAAT from spontaneous echocardiographic contrast and reverberation artifacts.

Key Words: Atrial fibrillation; Interobserver variability; Left atrial appendage; Thrombi; Transesophageal echocardiography

Transesophageal echocardiography (TEE) is regarded as the method of choice for visualizing left atrial appendage (LAA) morphology and function, including LAA thrombi (LAAT). Especially in patients before electrical cardioversion of atrial fibrillation, the detection of LAAT by TEE is of clinical relevance. In the beginning of the TEE era there were problems in differentiating LAAT from pectinate muscles using mono- or biplane probes which resulted in a high interobserver variability. Multiplane TEE probes are assumed to prove the diagnosis of LAAT. However, there are only limited data on the interobserver variability of different echocardiographic laboratories in diagnosing LAAT, and a thorough evaluation of the reasons for discrepant echocardiographic results has not been reported so far. Thus, the present study aimed to assess the interobserver variability of 2 independent echocardiographic laboratories for diagnosing LAAT by multiplane TEE and to analyze the factors responsible for interobserver disagreement.

Methods  The study population consisted of 50 patients in atrial fibrillation (25 from each echocardiographic laboratory) who had been evaluated by multiplane TEE in 2003. The studies had been performed by 3 experienced cardiologists from each laboratory according to local standards. In 11 patients the diagnosis of LAAT had been regarded as difficult in 1 laboratory. The echocardiographic equipment used was a Sonos 5500 ultrasonograph (Philips, Andover, MA, USA) with a 4.0–7.0MHz multiplane TEE transducer and a General Electric FiVe (General Electric Vingmed Ultrasound A/S, Horten, Norway) with a 5.0MHz multiplane TEE probe. Both transducers were not equipped with harmonic imaging. The TEE studies had been recorded on S-VHS videotape for subsequent analysis. All videorecordings were reviewed independently by 1 highly experienced observer from each echocardiographic laboratory in a blinded manner. LAAT were assessed as present, absent, or questionable. Both observers used the same criteria for the diagnosis of LAAT: a mass within the LAA cavity with (1) clear borders, (2) echogenicity distinct from the surrounding walls, (3) independent mobility, and (4) visible in 2 orthogonal planes. At least 3 criteria were required for the diagnosis of a definite thrombus. After the results had been obtained separately by each observer, controversial cases were reviewed together in order to clarify the reason for the discrepancy and to eliminate the category of questionable...
thrombi. In patients who underwent cardiac surgery, the intraoperative findings were compared with the results of TEE.

Statistical Analysis
Agreement between the 2 observers was estimated using the kappa measure of concordance. To calculate the kappa, the SAS® version 9.13 (SAS Institute, Cary, NC, USA) was used. A kappa ranging from 0.21 to 0.40 was classified as “fair”, from 0.41 to 0.60 as “moderate”, from 0.61 to 0.80 as “good” and >0.80 as “very good”.

Results
Patients
Of the 50 patients studied, 23 were females and 27 males with a mean age of 70±11 years (range 38–86 years). The indications for performing TEE were: before electrical cardioversion (n=17), assessment of valvular heart disease (n=13), suspected endocarditis (n=12), or cardiac source of embolism (n=8).

Diagnosis of LAAT
The prevalence of LAAT was 10% (observer 1) vs 12% (observer 2). A questionable LAAT was assessed in 6% vs 12% and a LAAT was excluded in 84% vs 76%, respectively (observer 1 vs observer 2). By comparing the results in each individual case, disagreement was found in 11 patients (22%): 7 from laboratory 1 and 4 from laboratory 2 (kappa =0.5). In 2 patients (1 from each laboratory) observer 1 diagnosed a definite LAAT, which was not confirmed by observer 2. In 3 patients 1 observer diagnosed a LAAT, whereas a questionable LAAT was assessed by the other observer. In 6 patients, 1 observer definitely excluded a LAAT, which was regarded a questionable LAAT by the other observer. These discrepancies were evenly distributed among both observers and the 2 laboratories and thus were not related to the echocardiographic equipment used (Philips vs General Electric system). The 11 controversial cases were jointly reassessed and a consensus was achieved in 10 patients. LAAT was regarded absent in 5 patients and questionable in 5 patients. One case remained discrepant (LAAT absent vs questionable). The final results were as follows: LAAT was regarded as present in 3 patients (6%), absent in 41 patients (82%) and questionable in 5 patients (10%), with 1 patient (2%) remaining controversial.

Reasons for Disagreement
After reassessment, there was still a high rate of questionable and controversial cases (12%), which were mainly related to technical aspects. By jointly reviewing the video recordings of the 11 controversial cases, the following reasons for disagreement on LAAT were identified.

1. Reverberation artifacts arising from the ridge between the LAA and the left upper pulmonary vein (Fig 1) mimicking LAAT (n=5). In some additional cases with these artifacts the TEE transducer had been rotated to between 110 and 130 degrees, and shadowing of the LAA body by the artifact had disappeared, thereby excluding the presence of LAAT.

2. Difficulty in differentiating severe left atrial spontaneous echocardiographic contrast (Fig 2) from LAAT (n=4). Compared with other patients with dense spontaneous echocardiographic contrast, in these controversial cases the number of documented heart cycles was not sufficient to distinguish a swirling blood flow pattern from a solid LAAT.

3. Prominent echogenic area of the atrioventricular groove with the appearance of a LAAT (n=1).

4. Misinterpretation of pectinate muscles as LAAT (n=1).

High gain setting in the region of the LAA and pericardial fluid in the transverse sinus was an additional problem in 1 patient each. Furthermore, magnification of the LAA was suboptimal in half of the patients, thus rendering the diagnosis of LAAT more difficult.

Reassessment of Questionable Thrombi and Anatomic Confirmation
After reassessment and elimination of the category “questionable thrombi”, the prevalence of LAAT was 14%
the differentiation between dense spontaneous echocardiographic contrast and LAAT remained difficult in a proportion of patients. In the beginning of the TEE era, pectinate muscles and the ridge between the LAA and the left upper pulmonary vein represented a diagnostic problem because they were mistaken for thrombi. By careful gain setting and varying transducer frequencies, reverberation artifacts arising from the ridge between the left upper pulmonary vein and LAA, imaging of this structure should include planes oblique to the pectinate muscles and side lobes of the appendage from LAAT, which is more easily accomplished by video documentation. These imaging planes are equally helpful in differentiating the pectinate muscles and side lobes of the appendage from LAAT (Fig 2).

Study Limitations

This study is limited by the small number of patients and its retrospective design. In addition, there was not a standardized protocol for evaluating the LAA. Furthermore, no TEE probes with the capability of harmonic imaging were available at the time of the study. Whether using the same echocardiographic equipment in both laboratories would have improved the results remains to be determined. Investigations of the same patient by both observers was impossible because the 2 echocardiographic laboratories were in different countries. Reviewing digital data instead of video recordings may have improved the results. However, documentation of multiple consecutive heart cycles is required for differentiating spontaneous echocardiographic contrast from LAAT, which is more easily accomplished by video documentation. Additionally, because the diagnosis of LAAT by multiplane TEE was anatomically controlled only in a very small subset of patients undergoing surgery, the true prevalence of LAAT could not be determined.

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References

6. Manning WJ, Silverman DI, Gordon SP, Krumholz HM, Douglas PS. Cardioversion from atrial fibrillation without prolonged anticoagulation with use of transesophageal echocardiography to exclude


