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Surgical or medical treatment for impending paradoxical embolism — report of 4 clinical cases and literature review

E. Fauveau¹; A. Cohen²; N. Bonnet³; K. Gacem³; H. Lardoux² on behalf of: Centre Hospitalier Sud Francilien
¹Service De Cardiologie, Corbeil Essonnes, France; ²Paris, France; ³Cholet, France

Endpoint: Thrombus straddling a patent foramen ovale (TSFO) is rare. It occurs in presence of pulmonary embolism, and it can be responsible of paradoxical embolism. The treatment is discussed, even if surgical treatment by thrombectomy is more often chosen. We aimed to precise better TSFO treatment depending on clinical context.

Material and methods: First TSFO case was reported by Nellessen in 1985. A bibliographic research in Pubmed from 1985 to 2005, found 75 cases of TSFO diagnosed by echocardiography. We analysed the 79 patients including 4 patients of our personal experience.

Results: Median age was 57.8 year old, with a majority of men (H/F ratio: 0.6). Pulmonary embolism was present in 97% of cases, and was severe in 42% of cases. Paradoxical Embolism was found in 47% of cases, with cerebral site in half of cases. The diagnosis was confirmed by transthoracic echography in 1/3 of cases and by transoesophageal echography in 2/3 of cases. It shows more frequently a long mobile serpentine thrombus. Treatment was described in 70 of 79 cases. Heparin treatment group was older (66 years), had more stroke (7/13) than surgery group (median age 55 year, 8 stroke/46).

Amongst 25 patients with hemodynamic compromise, surgery was the first therapeutical option (13/25). Proportionally, more patient received thrombolysis in this subgroup (8/25). Heparin or vena cave filter was more rarely chosen (4/25). In these subgroup, mortality was high (>30%) independantly of treatment.

Conclusion: Medical treatment by heparin is chosen as a second intention in an older population with more frequent comorbidities and strokes. However, mortality is not reduce in surgery group treatment compared to heparin in this review. Surgery seems to be justified in prevention of paradoxical embolism. Thrombolysis is more frequently chosen in the high risk population that cannot wait for surgery treatment, and is associated with the highest mortality.

Table 1. Immediate mortality (N=70)

surgery	heparin	thrombolysis	cava filter
mortality	7/46 (15%)	1/13 (8%)	4/10 (40%)
0/1			

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Is the diagnostic capacity of transesophageal echocardiography and cardiac disease found in peripheral embolism different from cerebral embolism?

A.T. Timoteo¹; L.M. Branco²; A. Galrinho²; A. Leal²; A. Santana²; J. Abreu²; J. Feliciano²; R. Ferreira²
¹Lisboa, Portugal; ²Santa Marta Hospital, Cardiology Dept., Lisbon, Portugal

Background: The search for a cardiac source of embolism by transesophageal echocardiography (TEE) is a very important tool in the evaluation of patients with embolic events.

Objectives: We sought to evaluate if the diagnostic capacity of TEE and the cardiac disease found is different in cerebral and peripheral embolism.

Methods: Study of 1110 consecutive patients studied since 1994 by TEE, after a normal transthoracic echocardiogram (TTE), for search of a cardiac source of embolism, due to an acute ischemic event, either cerebral or peripheral. We found 52 cases of peripheral embolism, and the remaining were acute cerebral ischemic events (confirmed by CT-scan).

Results: Male gender was more frequent in patients with cerebral events (53% vs 37%, p=0.035), with the same age (53±14 vs 57±18 years). There was a slight trend for a higher incidence of thrombi and more often, we found a potential cardiac source of embolism in peripheral embolism. See table.

Conclusions: In peripheral embolism, we found the same cardiac diseases as in cerebral embolism, but with a higher incidence in thrombi. It was also more often diagnostic of a cardiac source of embolism. However, the diagnostic rate was only 48%, less than what we expected to see in peripheral embolism, maybe due to the fact that large vegetations, thrombi or cardiac tumours, so often found in these cases, can be seen by TTE. The patients that underwent TTE were only the ones with normal TTE, outlining the importance of TEE after a normal TTE.

Table 1

(%)	Peripheral embolism	Cerebral embolism	p
Atrial septal defect	0	1	NS
Patent foramen ovale	4	9	NS
Atrial septum aneurisms	2	7	NS
Vegetation	2	0.7	NS
Tumour	0	0.4	NS
Thrombi	13	6	0.08
Aortic plaques >4 mm	15	9	NS
Diagnostic	48	35	0.08

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Patients with transient ischemic attack under oral anticoagulation: atrial thrombus resolution follow-up guided by transesophageal echocardiography

D.N. Chrissos¹; E.N. Tapanlis¹; A.A. Katsaros²; P.N. Stougiannos²; A.N. Kartalis²; N.C. Korovesi²; I.E. Kallikazaros²
¹Hippokraton Hospital, Cardiology Dept., Athens, Greece; ²Athens, Greece

Introduction: Transesophageal echocardiography (TEE) has been proven an exceedingly reliable imaging technique for detection of atrial thrombi, specifically in patients (P) who have undergone a transient ischemic attack (TIA) -far surpassing transthoracic echocardiography. The purpose of this study is to determine the usefulness of TEE as a means of recording the outcomes of anticoagulation therapy in P with TIA.

Methods: We studied 169 P (88 males and 81 females of mean age 70±10 years) who had recently sustained a TIA, the diagnosis of which was made clinically and by brain computerized tomography. All p underwent TEE, well tolerated and uncomplicated. P<0.05 was considered statistically significant.

Results: 47 P (27.81%) were found by TEE to have atrial thrombus: 5 P (10.64%) in left atrium cavity and 42 P (89.36%) in left atrium appendage. 15 P were followed for a period of one month to 2.5 years. TEE was repeated 4 and 8 weeks after beginning oral anticoagulation. Atrial thrombus was completely dissolved in 12 P (80%), while it was still present in 3 P (p=0.004). No thromboembolic events were manifested during the follow-up period.

Conclusions: It seems that administration of oral anticoagulation therapy results in elimination of thrombi in the majority of patients who have sustained a transient ischemic attack. Furthermore, the reduction in the incidence of thromboembolic events seems to be related mainly to the resolution rather than organization of the atrial thrombus.

ATRIAL FUNCTION AND DISEASE

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Atrial strain and strain rate analysis in patients with hypertrophic cardiomyopathy: functional findings and clinical impact

G. Pacileo¹; G. Limongelli¹; G. Salvo¹; M. Verrengia¹; A. Rea¹; T. Miele¹; S. Gala¹; R. Calabro¹
¹AO Monaldi, Dept., Napoli, Italy

Background: In patients with hypertrophic cardiomyopathy (HCM) atrial deformation significantly correlates with the risk of atrial fibrillation. However its clinical impact in patients with HCM has never been investigated.

Aim: To evaluate the atrial deformation by Strain (S) and Strain Rate (SR) analysis in pts with HCM and to correlate it with the onset of arrhythmias.

Methods: Our study population includes 53 subjects: 23 patients with HCM (mean age at study 30±12 years) (HCM group) and 20 age-matched healthy children (Control Group). Among patients with HCM 11/23 showed arrhythmias. S/SR analysis was performed from the apical views for the mid segments of interatrial septum (AS), left atrium (LA) lateral wall (LW), right atrial (RA) free wall (from the apical 4-chamber view), and LA inferior wall (IW) and LA anterior wall (AW) (from the apical 2-chamber view).

Results: Compared to control group, in HCM pts S/SR analysis showed a significant reduction of both LA and RA deformation (AS: S 49.6±20.9% vs 90.83±29.1%, p<0.001, SR 3±0.9 s-1 vs 4.24±1.2 s-1, p 0.003; LA LW: S 47.1±27.6% vs 80.83±15.5%, p<0.001, SR 2.88±1 s-1 vs 4.2±1.7 s-1, p 0.007; RA: S 65.5±33.4% vs 139.1±33.1%, p, SR 4.6±1.6 s-1 vs 5.8±1.8 s-1, p; LA IW: S 40.7±21.1% vs 78.5±18.2%, p, SR 2.7±1.1 s-1 vs 4.2±1.8 s-1, p 0.007; LA AW: S 44.3±22.1% vs 77.5±15.3%, p<0.001, SR 3±1.05 s-1 vs 4.9±2.4 s-1, p 0.009). Patients with arrhythmias showed significantly lower values of peak systolic S and SR (AS: S p 0.01, SR p 0.002; LA LW: S p 0.05; RA S p 0.03, SR 0.05; LA AW: S p 0.01, SR p 0.02; LA IW: S p 0.01, SR p 0.02).

Conclusions: HCM patients show significant reduction of atrial deformation, probably due to involvement also of the atrial myocardium and for abnormal loading conditions. In addition, compared to HCM patients without arrhythmias, those with arrhythmias have the lowest values of systolic peak S/SR, confirming the potential clinical impact of these new functional indexes.

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Left atrial strain/strain rate analysis in patients with dilated cardiomyopathy: correlation with clinical, electrocardiographic and echocardiographic findings

G. Limongelli¹; G. Pacileo¹; G. Di Salvo¹; R. Ancona¹; C. Maiello¹; G.E. Geppina Eusebio¹; R. Calabro¹; P. Calabro¹
¹AO Monaldi, Dept., Napoli, Italy

Aim: We analysed strain/strain rate (S/SR) parameters of the left atrium (LA) in patients with non-ischemic dilated cardiomyopathy, seeking potential correlation between S/SR and clinical, electrocardiographic (ECG) and echocardiographic (Echo) findings of the patients.

Patients and methods: Twenty-four patients (mean age 23±16 years) with clinical diagnosis of dilated cardiomyopathy (DCM) were selected for the study. Coronary artery disease and other secondary causes of heart failure

were excluded by full clinical and diagnostic investigation. Patients underwent a full clinical examination, including physical examination, NYHA functional class evaluation, 12 leads-ECG, conventional echocardiography, exercise test, metabolic exercise test, and 24-hour Holter ECG. Echocardiography was performed by System Seven (GE), equipped with TVI function. Left atrial S/SR were evaluated in 4 and 2 chambers view at the apical level of different walls (septal, lateral, anterior, inferior). Twenty-four age-BSA matched healthy individuals were studied as controls.

Results: Compared to normal in individuals, LA strain and strain rate were significantly reduced ($p=0.01$; $p=0.03$). We found a correlation between LA strain and PR interval ($r^2=0.299$; $\beta=-0.493$; $p=0.014$), QRS interval ($r^2=0.417$; $\beta=-0.646$; $p=0.001$), fractional shortening ($r^2=0.420$; $\beta=0.648$; $p=0.007$), ejection fraction ($r^2=0.527$; $\beta=0.726$; $p=0.0001$), left ventricular end-diastolic dimension ($r^2=0.354$; $\beta=-0.595$; $p=0.02$), nonsustained ventricular tachycardia ($r^2=0.382$; $\beta=-0.618$; $p=0.02$). Also, we found a correlation between LA strain rate and PR ($r^2=0.22$; $\beta=-0.469$; $p=0.02$), QRS ($r^2=0.345$; $\beta=-0.587$; $p=0.003$), fractional shortening ($r^2=0.306$; $\beta=0.053$; $p=0.026$), ejection fraction ($r^2=0.223$; $\beta=0.472$; $p=0.027$), left ventricular end-diastolic dimension ($r^2=0.205$; $\beta=-0.453$; $p=0.026$), nonsustained ventricular tachycardia ($r^2=0.180$; $\beta=-0.424$; $p=0.049$). After a multivariate model, we observed a significant, negative correlation between LA strain and PR interval ($p=0.02$; $\beta=-0.580$).

Conclusions: LA properties, analysed by S/SR analysis, correlate significantly to morphologic and electric properties of left atrium and ventricle. An independent correlation between LA deformation properties and PR interval may suggest a more impaired left atrial deformation and functional properties in patients with atrio-ventricular conduction delays.

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Atrial myocardial deformation properties and arrhythmias in patients after atrial septal defect closure

G. Di Salvo¹; G. Pacileo¹; G. Limongelli¹; M. Verrengia¹; A. Rea¹; T. Miele¹; G. Santoro¹; R. Calabro¹

¹Second University of Naples, Cardiology Dept., Naples, Italy

Atrial arrhythmias are common in the natural history as well as in the late postoperative course of patients with atrial septal defect (ASD).

Previous studies demonstrated electrophysiologic disturbances in ASD patients due to ASD itself and surgery. Other reports suggested an increase in atrial chamber stiffness after ASD device closure. The prognostic value of atrial myocardial deformation properties in patients with an ASD after correction has never been studied. Thus, the aim of the present study was to evaluate both left (LA) and right atrial (RA) function of children after ASD using strain (?) and strain rate (SR) imaging and to assess their prognostic value. In all, 100 subjects formed our studied sample: 50 patients after successful ASD (mean age: 9 ± 3 years, age at ASD closure: 7 ± 3 years, 70% of them had percutaneous closure) and 50 age-sex-matched referents. All patients underwent ASD correction at least 6 months before the study. All subjects underwent a standard echo study, and SR imaging evaluation. The follow-up lasted at least one year. Every 3 months patients underwent exercise ECG and 24h ECG monitoring. Arrhythmias were regarded as end-point. ASD patients showed a peak systolic ϵ and SR values significantly reduced ($p<0.01$) in both RA ($\epsilon=47\pm 17\%$; $SR=3.1\pm 1$ 1/s) and LA ($\epsilon=40\pm 13\%$; $SR=2.8\pm 1.3$ 1/s) when compared to controls (RA: $\epsilon=100\pm 40\%$; $SR=5.9\pm 1.2$ 1/s; LA: $\epsilon=84\pm 19\%$; $SR=4.1\pm 1$ 1/s). During follow-up 30% of our patients had at least one episode of supraventricular arrhythmias. Patients with arrhythmias has significant lower values of atrial myocardial deformation properties ($\epsilon=33\pm 12\%$; $p<0.05$). In a multivariate analysis, atrial ? was negatively correlated with age at correction, surgical correction, and device dimension. Our study demonstrated atrial myocardial deformation properties as a good index to non invasively assess the arrhythmic risk of ASD patients after correction. Moreover, our findings suggest that early correction with small device (when possible) could be the best treatment for ASD patients.

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Assessment of regional left atrial deformation and its timing by strain echocardiography

E. Donal¹; P. Raud-Raynier²; C. De Place³; D. Coisne²; D. Herpin²; P. Mabo³

¹Rennes, France; ²University Hospital, Cardiology Dept., Poitiers, France;

³University Hospital, Cardiology Dept., Rennes, France

Background: The left atrium (LA) is a contractile and reservoir chamber. Its remodeling is associated with the atrial fibrillation (AFib) and a thrombo-embolic risk. In AFib patient, the remodeling process is associated with an electrical heterogeneity of LA tissue activation. It might be relevant to assess, using a non-invasive trans-thoracic echocardiography, the mechanical LA function and its potential heterogeneity. It might be an elegant way to characterize LA remodelling process.

Purpose: To test whether mechanical regional LA function might be assessed using a transthoracic strain echocardiographic study and to look for its potential heterogeneity in a control and in a stroke population.

Methods: 28 consecutive patients referred for echocardiography in the aetiological assessment of an acute ischemic stroke were compared to

a control population ($n=26$). We measured LV size and function, but also LA size and function using global function parameter such as the ejection force or the ejection fraction, and regional parameters (velocity, displacement and deformation) in 5 locations (bottom of the LA, basal and mid portions of lateral and septal LA walls). The timing of regional mechanical event was also measured in the Stroke group and the control one.

Results: The velocity (DTI, cm/s) and displacement (Tissue tracking, cm) analysis was influenced by the above left ventricular wall. Strain appeared relevant and strain rate difficult to interpret. The mean LA regional deformation (strain, %) was significantly higher in the control group (41.1 ± 14.8 vs 35.3 ± 12.9 , $p<0.01$) compared the stroke one. Also the mean delay between the ECG Q-wave and the peak of LA regional deformation was 389.8 ± 62.3 msec in the control group and 394.6 ± 61.5 in the stroke one. The dispersion between these delays within the LA was significantly higher in the stroke group compared to the control one (75.3 ± 35.5 vs 59.9 ± 34.4 , $p<0.01$).

Conclusion: Regional LA function assessment using transthoracic echocardiography and the strain capabilities is feasible and might be a predictive parameter of atrial fibrillation or/and arterial thrombo-embolic event.

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Total atrial activation time: New echocardiographic tool for identifying patients with an atrial substrate vulnerable for AF

F. Roshanali^{1,2}; F. Roshanali^{1,2}; S. Oraii^{2,2}; M. Eftekharzadeh^{2,2};

A. Mohammadi^{2,2}; P. Kaffai^{2,2}

¹Tehran, Iran (Islamic Republic of); ²Day General Hospital, Tehran, Iran (Islamic Republic of)

Background: We evaluate value of tissue Doppler echocardiography by trans-thoracic for measure total atrial activation time to identify with an atrial substrate vulnerable for AF.

Methods: We studied 84 patients in sinus rhythm (40 patients with history of AF) undergoing trans-thoracic echocardiography. We measured PA-tdi interval as the time from initiation of the electrocardiographic P-wave to the lateral left atrial tissue Doppler signal.

Results: AF history patients differed from sinus rhythm patients by a lower ejection fraction (43 ± 15 versus $50\pm 12\%$), a reduced maximal A-wave transmitral Doppler flow velocity (45 ± 20 versus 55 ± 17 cm/s), an increased total atrial volume (55 ± 10 versus 45 ± 8 mL), and a prolonged PA-tdi interval (183 ± 32 versus 135 ± 23 ms, respectively; $p<0.01$ for all). Also AF history patients were older than SR group (68 ± 10 versus 60 ± 12 years). Pa-tdi interval was only independent discriminator of history of AF. (1.1 for every 1 msec increment, $p<0.001$).

Conclusion: Total activation time by trans-thoracic tissue Doppler echocardiography could be valuable to identifying patients vulnerable for AF.

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LA volumes, global left atrial strain and strain rate in normal hearts determined by 2-D echocardiography

R. Vianna¹; K.S. Lee¹; C.A. Moreno¹; R.J. Buono¹; V.P. Keating¹;

C.M. Baxter¹; C.P. Appleton¹

¹Mayo Clinic College of Medicine, Div. of CV Diseases, Scottsdale, United States of America

Introduction: Left atrial (LA) maximal volume by 2-D echocardiography is associated with multiple adverse cardiovascular (CV) outcomes. Techniques that detect early LA volume abnormalities and LA contractile dysfunction may help with early prevention of adverse CV events.

Objective: This project sought to determine normal LA volumes, LA ejection fraction (LAEF) and global LA strain and strain rate during LA contraction using 2D echo and 2D speckle tracking (2D-ST) techniques.

Methods: Forty seven healthy volunteers with no cardiac or diabetic history, and normal exercise capacity, systolic BP (<125 mm Hg), ECG, and echocardiographic findings were included in this study. Apical 4-chamber view images were analyzed using an EchoPac workstation (GEMS, Milwaukee, WI). LA volumes including maximum, minimum and volume prior to atrial contraction (Pre-A) were calculated by the method of disks. Global LA strain and strain rate were measured using 2D Strain analysis software.

Results: All values are expressed as mean \pm SD. Mean age was 39 ± 8.5 years. 53% were female. Average HR was 63 ± 9.7 BPM and average PR interval 138 ± 17.2 ms. Global strain at atrial contraction was $-10\pm 3.3\%$ and strain rate $-1.8\pm 0.6\%$ s⁻¹. Volumes and changes during the atrial cycle are shown in the table below.

Conclusion: Average normal LA minimum volume is 8 ml/m² with an LAEF of 36%, and peak global LA strain rate at atrial contraction of -10%. Our data begins to establish the relation of LA volumes and contractile performance. Increased LA minimum volume and a reduction in strain may be an early index of LA dysfunction that deserves further study.

Table 1

	Volume (ml/m ²)	% Change
Maximum	24 \pm 4.9	-
Pre-A	14 \pm 3.4	-
Minimum	8 \pm 4.9	-
? LA Max to pre-A	9.9 \pm 2.6	64 \pm 7.8
? pre-A to Min (LAEF)	5.5 \pm 1.7	36 \pm 7.8

Normal echocardiographic volumes and changes during the atrial cycle.