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## RESEARCH ARTICLE

# Revision of Echocardiographic Indications and Findings in Neurologically Ill Patients

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### Abstract:

#### **Background and Objective:**

Little is known about the general indications for echocardiography and the prevalence of abnormalities detected by echocardiography in patients who are referred from a neurological department. Left ventricular hypertrabeculation/noncompaction (LVHT) is associated with neuromuscular disorders and embolism. The aim of the study was to assess the indications for echocardiography in patients from a neurological department and to review the cine-loops of the examinations in order to assess the frequency of abnormal echocardiographic findings with special regard to LVHT.

#### **Methods and Results:**

Included were 126 patients, 58 females (mean age 65 years). Indications were stroke (84%), heart failure (6%), endocarditis (6%) and arrhythmia (3%). The most frequent abnormalities were impaired relaxation (71%) and left ventricular wall thickening (63%). Females were older (68 vs. 62 years,  $p = 0.0214$ ) and more frequently had normally sized left ventricles than males (98 vs. 88%,  $p = 0.0376$ ). Patients  $\geq 66$  years more frequently had stroke as an indication (91 vs. 77%,  $p = 0.05$ ), showed a thickened myocardium (72 vs. 53%,  $p = 0.0272$ ), valvular abnormalities (52 vs. 13%,  $p = 0.0000$ ) and impaired relaxation (86 vs. 54%,  $p = 0.0001$ ) than patients  $< 66$  years.

LVHT was diagnosed in 3 patients; in one of them the diagnosis was already known. In 45% LVHT and in 38% left ventricular thrombus could neither be excluded nor established since the image quality was poor.

#### **Conclusion:**

Care should be taken to visualize the left ventricular apical regions when investigating patients referred from a neurologic department in order not to overlook LVHT and thrombi within the left ventricular apex.

**Keywords:** Echocardiography, Stroke, Neuromuscular disorders, Cardiomyopathy.

## INTRODUCTION

Most studies about echocardiography in neurologically ill patients included patients with ischemic strokes or transient ischemic attacks and are concentrated on the detection of cardiac sources of embolism (*e.g.* atrial fibrillation, left ventricular aneurysm, cardiomyopathies, intracardiac masses, valvular abnormalities, aortic atheroma, mechanical valve prosthesis, mitral valve prolapse, mitral annulus calcification, atrial septal aneurysm or patent foramen ovale) [1 - 6].

Little is known about the general indications for echocardiography and the prevalence of abnormalities detected by echocardiography in patients who are referred from a neurological department. One of the echocardiographic findings

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associated with neurological disease is left ventricular hypertrabeculation/noncompaction (LVHT). LVHT is a cardiac abnormality frequently associated with neuromuscular disorders [7]. LVHT is increasingly acknowledged as a cardiac source of embolism but only cursorily mentioned in the recommendations for echocardiography use in the diagnosis and management of cardiac sources of embolism [6, 8].

Thus, aim of the present study was to revise the indications for echocardiography in patients who were referred for transthoracic echocardiography from a neurological department and to review the cine-loops of the echocardiographic examinations in order to assess the frequency of abnormal echocardiographic findings with special regard to LVHT.

## METHODS

Included were consecutive patients who were referred from a neurologic department for echocardiographic evaluation within a period of 6 months. We excluded patients for whom no cine-loops of the echocardiographic investigation were available. All patients were investigated with the same echocardiographic machine (VIVID 7) using a 3.5 MHz transducer. The echocardiographic examinations were performed by 3 different physicians with at least 10 years experience in echocardiography. The following parameters were registered: indication for echocardiography, age and sex. By reviewing the cine-loops of the echocardiographic examination, the following abnormalities were registered: left ventricular systolic function (assessed as normal, moderate and poor), diastolic function (assessed as normal, disturbed relaxation or disturbed compliance), left ventricular size (assessed as normal, moderately and severely increased), left ventricular wall thickness (assessed as normal or thickened), valvular abnormalities (assessed as absent or present), prevalence of LVHT (assessed as absent, present or questionable), endocarditis (assessed as absent, present or questionable) and thrombi (assessed as absent, present or questionable). Additionally, we looked for any potential cardioembolic sources, as listed in the introduction. It was also recorded if an abnormality could not be assessed due to poor image quality.

Echocardiographic registration, measurements and assessment of the left ventricular size and wall thickness, systolic and diastolic function, and diagnosis of valvular abnormalities, endocarditis and thrombus were carried out according to current guidelines [9]. Two-dimensional and Doppler echocardiographic criteria for the diagnosis of LVHT were: >3 trabeculations protruding from the left ventricular wall, apically to the papillary muscles, visible in one echocardiographic image plane at end-diastole; trabeculations form the noncompacted part of a two-layered myocardial structure, best visible at end-systole; intertrabecular spaces perfused from the ventricular cavity, as visualized on colour Doppler imaging. Trabeculations were defined as structures moving synchronously with ventricular contractions, distinct from ventricular bands, false tendons and prominent papillary muscles [8]. Additionally, we registered if transoesophageal echocardiography had been performed.

Group comparisons were analysed by the two-sided Fisher exact test except for differences in the mean age which were assessed with the t-test. All statistical analyses were performed by using the statistical software package R [10].

## RESULTS

Included were 126 patients, 58 females, with a mean age of 65 years, ranging from 21 to 93 years. The indications for echocardiography were stroke or ischaemic attack in 106 cases (84%), heart failure in 7 cases (6%), suspected endocarditis in 6 cases (5%), arrhythmia in 4 cases (3%) and suspected cardiac involvement in systemic disease in 3 cases (2%).

Left ventricular systolic function was assessed as normal in 111 patients (88%), moderately reduced in 12 (10%) and poor in 3 (2%). Left ventricular size was normal in 117 patients (93%), moderately increased in 7 (6%), severely increased in one patient (1%) and could not be assessed due to poor image quality in one patient. The left ventricular wall thickness was normal in 45 patients (36%), thickened in 79 patients (63%) and could not be assessed due to poor image quality in 2 patients (2%). Valvular abnormalities were seen in 42 patients (33%) and could not be assessed due to poor image quality in 8 patients (6%). Endocarditis was diagnosed in one patient (1%), assessed as questionable in 8 patients (6%) and could not be assessed in further 14 patients (11%) due to poor image quality. A left ventricular thrombus was diagnosed in 2 patients (2%). The most frequent echocardiographic abnormality was impaired relaxation in 89 patients (71%).

Female patients had a higher mean age than males (68 vs. 62 years,  $p = 0.0214$ ) and had more frequently normally sized left ventricles than males (98 vs. 88%,  $p = 0.0376$ ). No further differences were observed between females and males. Patients older than the median age ( $\geq 66$  years) had more frequently stroke or transient ischaemic attack as

indication for echocardiography (91 vs. 77%,  $p = 0.05$ ), showed more frequently a thickened myocardium (72 vs. 53%,  $p = 0.0272$ ), valvular abnormalities (52 vs. 13%,  $p = 0.0000$ ) and Doppler-sonography signs for impaired relaxation (86 vs. 54%,  $p = 0.0001$ ) than patients <66 years. No further differences were observed between young and old patients.

LVHT was diagnosed in 3 patients, in one of them the diagnosis had already been established. In the other two patients, only review of the echocardiographic recording disclosed the diagnosis which has been overlooked at the initial echocardiographic examination. In 45% of the patients the diagnosis of LVHT could neither be excluded nor established since the image quality, especially of the apical region of the left ventricle, was poor. Because of similar reasons in 38% of the patients the diagnosis of a left ventricular thrombus could not be excluded or established.

In 8 patients (6%) with stroke or transient ischaemic attack transoesophageal echocardiography (TEE) was carried out, either because of suspected endocarditis ( $n = 4$ ) or because of suspected patent foramen ovale in 4 patients with cryptogenic stroke. TEE confirmed endocarditis in two of them. No patent foramen ovale was detected by TEE.

## DISCUSSION

This study shows that the most frequent echocardiographic indications in neurologically ill patients were the search for cardiac sources of embolism after stroke or ischaemic attacks. The most frequent echocardiographic abnormalities were left ventricular diastolic dysfunction and left ventricular wall thickening. Potential cardioembolic sources were rarely detected by echocardiography. In nearly half of the cases, the apical segments of the left ventricle were not well visualized thus impeding the diagnosis of left ventricular thrombi and LVHT. TEE with its superiority to transthoracic echocardiography for the detection of left atrial thrombi, patent foramen ovale, endocarditis and aortic atheroma, was only carried out in 6% of the cases.

The most frequent reason for left ventricular wall thickening and diastolic dysfunction is long-standing arterial hypertension [11, 12]. Thus, it is not surprising that these abnormalities were the most frequent and associated with increased age. Arterial hypertension is also one of the main risk factors for the development of cardiovascular morbidity and atrial fibrillation [13]. Although the prevalence of atrial fibrillation was not assessed it can be assumed that a considerable number of patients had suffered from embolic stroke due to atrial fibrillation.

The low detection rate of cardioembolic sources may be explained by the low rate of patients who underwent TEE and the poor image quality. The rate of stroke patients who underwent transthoracic as well as TEE reported in the literature varies between 8-23% [3, 4]. The diagnostic role of TEE in stroke patients has been challenged recently since the detection of left atrial thrombi has lost its therapeutic impact due to increasing evidence that anticoagulation in atrial fibrillation for secondary stroke prevention is indicated, irrespective if a left atrial thrombus is present or not [14]. Similarly, the detection of a patent foramen ovale in patients without venous thromboembolism has lost its therapeutic relevance since three randomized trials failed to demonstrate the superiority of patent foramen ovale closure over medical treatment in secondary stroke prevention [15].

Furthermore, the lack of visualization of the left ventricular apex in nearly half of the patients may have played a role in not detecting sources of embolism. Whereas left ventricular thrombi have been known and acknowledged as occurring in poorly contracting myocardial regions or ventricular aneurysms, thrombi may also develop in patients with LVHT with good systolic function within the intertrabecular spaces [16, 17]. Detection of LVHT is not only important in stroke patients as a potential cardiac source of embolism but also in patients with various neuromuscular disorders since it may be associated with arrhythmias and the risk of developing heart failure [7]. Since LVHT is frequently located in the apical regions of the left ventricle, care has to be taken to visualize that region, also in well contracting ventricles.

Limitations of the study are that the consequences of the echocardiographic findings were not assessed and that no interobserver variability studies were carried out between the initial study and the reviewer's results. Cardiovascular comorbidities as well as the prevalence of atrial fibrillation were not assessed.

## CONCLUSION

It is concluded that more care should be taken to visualize the left ventricular apical regions when investigating patients referred from a neurologic department in order not to overlook LVHT and thrombi within the left ventricular apex.

## LIST OF ABBREVIATIONS

LVHT	=	Left Ventricular Hypertrabeculation/non-compaction
TEE	=	Transoesophageal Echocardiography

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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