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TISSUE DOPPLER ECHOCARDIOGRAPHY IN CURRENT RESEARCHES AND ITS POTENTIAL IN ISCHAEMIC STROKE DIAGNOSIS AND PROGNOSTICATION

Introduction and background. The cardiac structures motion velocities may be assessed by means of tissue Doppler imaging (TDI), that is meant to filter out high-frequency, low-amplitude and higher velocity blood flow signals and to detect higher amplitude, lower-velocity ones. The method is limited by angle-dependency, respiratory motions of the patient, reverberation artefacts while scanning more superficial structures. In addition, the scanner is required to provide a frame rate of at least 100-150 frames per second. The measure of the change of shape of a region, the strain, and its relative amount over time, the strain rate, can also be assessed by TDI [22]. There are several TDI modes to assess the myocardial tissue movement with, those include pulse-wave (PW) tissue velocity, colour tissue velocity imaging (TDC) and curved anatomical M-mode (CAMM) [11]. The proper technique is required, in particular, in PW TDI mode for placing and maintaining sample volume position, as well as, for adjusting the lowest possible gain setting [22].

Tissue Doppler capabilities are still applied in various scientific researches. In patients with great prevalence of cardiovascular diseases and cardiovascular risk factors, however, with normal left ventricle ejection fraction and no heart failure, early mitral annular velocity, septal e' , was shown to be an incremental prediction factor of mortality and patient admittance due to cardiovascular causes. The value, measured by TDI, was reported to be applicable and dependable in practice [18]. On the contrary, Nistri S et al. [18] do not advise the usage of the conventional PW Doppler-derived mitral peak early filling velocity, E , to e' ratio, the E/e' , as a single prognostication and diastolic function assessment method in patients with no signs of heart failure.

In the article by Simpson T F et al. [25] a PW TDI score of $S' + E' \geq 20$ cm/s was presented as a highly sensitive and specific reliable predictor for normal global left ventricle function. The lateral mitral annulus early-diastolic tissue velocity (the lateral- e') was presented to be related to the reversible character of left ventricle dysfunction and to be a reliable predictor of clinical outcomes in non-ischemic left ventricular dysfunction [13].

TDC and PW TDI were applied for prognostication and systolic function assessment in Anderson–Fabry disease [8], PW TDI was used in the morphological and functional evaluation of the left ventricle in asymptomatic female carriers of Duchenne muscular dystrophy gene mutations [16].

The TDI was applied to assess the septal atrial conduction time (sPA-TDI) in transcatheter atrial septal defect treatment [19]. The asynchrony and the electromechanical delay in atrial septal defects [19], atrial fibrillation (AF) followed by electrical cardioversion [30], and in cardiomyopathy [5] were also assessed with PW TDI and electrocardiography.

The myocardial performance index [29], derived by PW TDI in the COVID-19 patients [12] and by TDC in the research on Anderson–Fabry disease [8], was evaluated.

The management of AF may also benefit from a multidisciplinary and integrated approach, and echocardiography modalities, such as TDI, may improve the AF assessment in routine clinical practice, as presented in the research on AF imaging [15].

Purpose. The aim of this article was to look through the current scientific researches on TDI echocardiography values, those may be useful in practice for cardiac function evaluation in ischemic stroke patients.

Materials and methods. The search strategy for this brief review included requests “ischemic stroke and tissue Doppler”, “ischemic stroke and tissue Doppler and E’ septal”, “tissue Doppler E/E’ and ischemic stroke”, sorting “by relevance” was applied, articles dated the year 2019 and later were included. Additional search entries were found by manual search through the reference lists from the original researches and textbooks. As a free search engine Google Scholar was used initially. For every relevant article a secondary search for related articles was performed.

Results. The TDI was presented to be applied in different researches on diagnosis and prognostication of ischaemic stroke. Let us look through the most current ones.

Thus, PW TD was applied in the research on echocardiographic markers in cryptogenic stroke with incidental patent foramen ovale [28]. The left atrial (LA) volume index LAVI/a’, presenting left atrium remodelling in stroke patients, was obtained using TDI [24]. The myocardial performance index, derived by PW TDI, was assessed in stroke [20] patients.

The E/e’ ratio was shown to be in an independent association with ischaemic stroke in patients without AF, with atherothrombotic type occurring more often, than cardiogenic one. This ratio was also limitedly, as compared to left atrial dimension, associated with incidence of AF [3].

The LA reservoir strain and electrocardiographic P-wave to PW TDI derived A’ duration assessment after initial CHA₂DS₂-VASc scoring was presented to be a useful additional factor to stratify stroke risk with [14].

The diastolic dysfunction indicators were shown to correlate strongly with unfavourable prognosis in undetermined aetiology ischaemic stroke patients [1]. The echocardiographic sequential examinations are recommended to exclude possible AF in such patients for the period of 2 months after the discharge from the hospital [1].

The PW and TDC TDI-derived mass peak antegrade velocity of thrombus, the Va, assessed at the level of the mobile portion of intraventricular thrombus, was presented as a useful additional echocardiographic prognostication factor of a higher embolic risk, however, it cannot be applied to influence decisions and the standardised criteria are still to be developed [26].

The lateral total conduction time, the interval between the onset of P-wave in lead II of the electrocardiogram (ECG) and the peak A’-wave of the lateral (l-PA TDI) part of mitral valve annulus was reported to be a factor that may develop the AF risk assessment and management beneficially [17].

The septal total conduction time, the interval between the onset of P-wave in lead II of the ECG and the peak A’-wave of the septal (s-PA TDI) part of mitral valve annulus, was reported to be a strong prognostication factor of subclinical AF in embolic stroke of unidentified source [23].

Subtle differences in the apparently normal diastolic function evaluated by TDI-derived indices and blood flow/tissue velocity ratios in young patients with cryptogenic stroke and healthy ones were shown [21].

The LA strain evaluation by TDI may be presented as a potentially reliable method to use in stroke patients as a prognostication modality [10], [27], although the validation researches are needed [27]. PW TDI is also applied alongside with other methods, as speckle tracking, for left atrial strain assessment in AF and stroke prediction [2].

The cardiac stiffness in relaxation phase in the acute period ischaemic stroke subjects, if increased, was shown to influence negatively the cardiopulmonary adequacy in the rehabilitation period [6].

Although the TDI values and indices have been studied for decades [7], and the researches on reference values have been being conducted [4], the further studies [9], are still of a scientific and practical interest.

Conclusion. Although the further researches on validation and standardisation of normal values ranges are shown to be needed, tissue Doppler imaging is presented to be a feasible and reliable method, that is successfully used for cardiac function evaluation in patients of various pathology, and its parameters from current scientific researches in addition to the well-known ones, required during stroke treatment, may be also useful for ischaemic stroke prediction, advanced diagnosis and outcome prognostication.

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