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ORIGINAL ARTICLE

M-mode apical systolic excursion: A new and simple method to evaluate global left ventricular longitudinal strain

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Abstract
Introduction: Since M-mode measurements can assess deformation of specific regions of the left ventricle, we hypothesized that M-mode measurements like M-mode apical systolic excursion (MMASE) and mitral annular plane systolic excursion (MAPSE) may be correlated with left ventricular longitudinal strain (LVLS).
Methods: All subjects of the study underwent a full echocardiographic evaluation and MMASE and MAPSE measurement. Three-dimensional wall motion tracking (3D-WMT) was performed.
Results: Thirty-one patients were evaluated. Significant correlations between MAPSE and LVLS (−0.372; p=0.04) and between MMASE and LVLS (−0.398; p=0.027) were found. LVLS was linearly related to MAPSE and MMASE (in mm) as follows: ST=−10.6 −0.4 * MAPSE (r2=0.14) and ST=−13.1 −0.5 * MMASE (r2=0.16).
Conclusions: Our results demonstrate that simpler and faster methods than strain based on complex speckle analysis can also have a role in predicting subclinical left ventricular systolic dysfunction.

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PALAVRAS-CHAVE
Ecocardiograma Modo-M;
Strain longitudinal;
3D *wall motion tracking*

Excursão sistólica apical em Modo-M: um método novo e simples para avaliação do *strain* longitudinal global do ventrículo esquerdo

Resumo
Introdução: Uma vez que as medições em Modo-M podem determinar a deformação de regiões específicas do ventrículo esquerdo, neste trabalho é colocada a hipótese de que medidas como a excursão sistólica apical em modo-M (MMASE) e a MAPSE podem ser correlacionadas com o *Strain* Longitudinal do Ventrículo Esquerdo (SLVE).
Métodos: Todos os indivíduos do estudo foram submetidos a uma avaliação ecocardiográfica completa, à medição da MMASE e da MAPSE. Foi ainda realizado o 3D-*wall motion tracking* (3D-WMT).
Resultados: Foram avaliados 31 pacientes, tendo sido obtida uma correlação estatisticamente significativa entre a MAPSE e o SLVE (−0.372; p=0.04) e entre a MMASE e o SLVE (−0,398; p=0,027). Estas medidas apresentaram uma correlação linear: ST=−10,6 -0,4 * MAPSE (r2=0.14) and ST=−13,1 −0,5 * MMASE (r2=0,16).
Conclusão: Os nossos resultados demonstram que métodos mais simples e rápidos que o *strain* podem também ser úteis na determinação da disfunção subclínica sistólica do ventrículo esquerdo.

List of abbreviations

3D-WMT	three-dimensional wall motion tracking
LV	left ventricular
LVLS	global left ventricular longitudinal strain
MAPSE	mitral annular plane systolic excursion
MMASE	M-mode apical systolic excursion

Introduction

Cardiac echocardiography has evolved and new methods have been developed to assess left ventricular (LV) mechanics. One of these techniques is three-dimensional wall motion tracking (3D-WMT), which enables assessment of global LV longitudinal strain (LVLS), radial and circumferential strain simultaneously. It has been described as a reliable parameter that is less dependent on loading conditions[1] and allows the measurement of left ventricular mechanics.

Theoretically, M-mode measurements can assess deformation of specific LV regions, so it is to be expected that the study of different regions of the myocardium will allow global LV deformation to be predicted. Mitral annular plane systolic excursion (MAPSE) is a parameter used to assess left ventricular longitudinal function,[2] and has been recently correlated with LVLS, as an early predictor of systolic dysfunction.[3]

Our goal is to assess whether M-mode apical systolic excursion (MMASE) and MAPSE could be correlated with LVLS.

Methods

Consecutive patients aged >18 years with preserved LV systolic function and a good acoustic window were recruited. All subjects underwent a full echocardiographic evaluation. MAPSE was measured in 4-chamber view with an M-mode cursor positioned through the mitral annulus, close to the lateral wall. MMASE was calculated by subtracting the distance between the apical line in M-mode in end-diastole and in end-systole. These distances were measured in 4-chamber view with the left ventricle centered in the scanning sector and the M-mode cursor positioned through the apex. The distance between the apical line and the mitral valve was measured in end-diastole and end-systole, as shown in Figure 1.

Three-dimensional wall motion tracking (3D-WMT) was performed with an Artida system and a PST-25SX probe. Global LVLS, radial strain, circumferential strain and area tracking were determined. Statistical analysis was performed using SPSS version 20.0.

Results

Thirty-one patients were enrolled (mean age 60.1± 21.0 years; 54.8% men). Eighteen (58%) patients were hypertensive, eight (25.8%) had dyslipidemia, and two (6.5%) had diabetes.

In terms of two-dimensional echocardiographic parameters, mean LV ejection fraction was 65±9%, mean LV diastolic diameter 44.8±6.9 mm, mean MAPSE 16.7±2.7 mm and mean MMASE 8.6±2.4 mm. On 3D-WMT analysis, mean LVLS of −17.3±2.4, mean LV radial strain of 29.1±7.8 and mean LV circumferential strain of −28.2±7.3 were observed.

Analysis of the dataset showed statistically significant correlations between MAPSE and LVLS (−0.372; p=0.04) and between MMASE and LVLS (−0.398; p=0.027), as shown in Table 1. This association was slightly stronger for MMASE. There was no significant statistical correlation between these two parameters and LV ejection fraction or

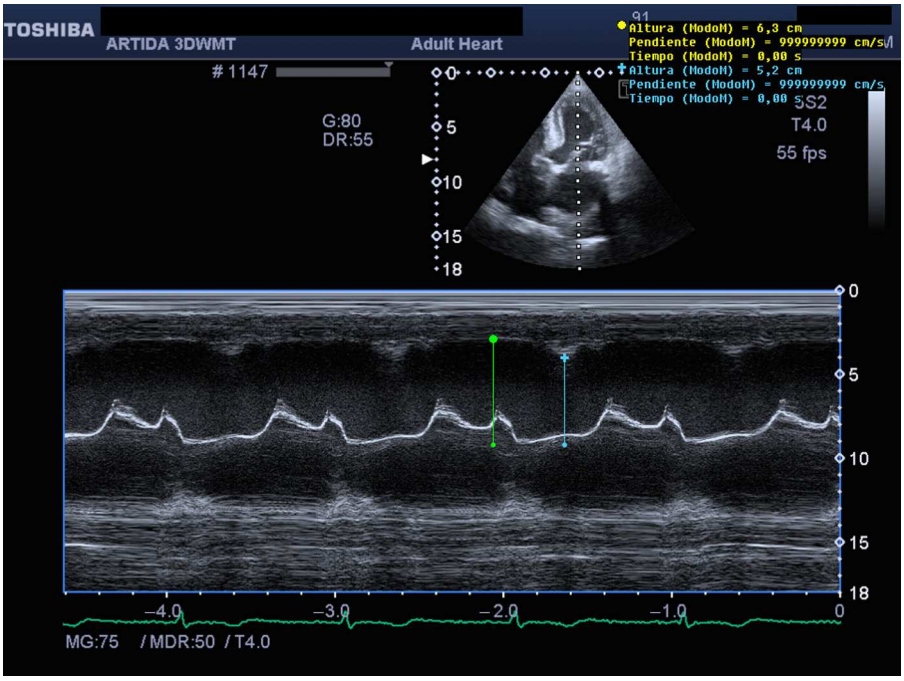

Figure 1 Example of M-mode apical systolic excursion measurement.

Table 1 Correlations.

	Age (p)	LVLS (p)	MAPSE (p)	MMASE (p)
Age (p)	1	0.522 (0.003)	−0.305 (0.095)	−0.425 (0.017)
LVLS (p)	0.522 (0.003)	1	−0.372 (040)	−0.398 (0.027)
MAPSE (p)	−0.305 (0.095)	−0.372 (040)	1	0.479 (0.006)
MMASE (p)	−0.425 (0.017)	−0.398 (0.027)	0.479 (0.006)	1

LVLS: left ventricular longitudinal strain; MAPSE: mitral annulus plane excursion; MMASE: M-mode apical systolic excursion.

radial or circumferential strain. LVLS was linearly related to MAPSE and MMASE (in mm) as follows: ST=−10.6 −0.4 * MAPSE (r2=0.14) and ST=−13.1 −0.5 * MMASE (r2=0.16). Although it was not an objective of the study, we also observed a correlation between age and LVLS of 0.52 (p=0.003) and MMASE of −0.425 (p=0.017). There was no statistically significant correlation between age and MAPSE.

Discussion

This study demonstrates that although somewhat primitive, M-mode echocardiography can provide options for the study of LV mechanics. With our new method of evaluation, MMASE was correlated with 3D-WMT longitudinal strain results, and so may have the ability to evaluate LV mechanics.

MAPSE has been reported as a method for LV evaluation in patients with LV systolic dysfunction[4,5] and has recently been shown to correlate with LV function measurements, such as longitudinal strain and apical rotation in patients with heart failure and preserved ejection fraction.[3] Our study confirmed that MAPSE correlates with LVLS and is a parameter that can assess LV longitudinal function, but the correlation with LVLS was stronger for MMASE. We also observed that longitudinal strain was worse when MAPSE and MMASE values decreased, and with aging. Kuznetsova et al.[6] reported age as an independent predictor of worse longitudinal strain. We also described a relation between MMASE and age that indicates worsening of apical excursion with increasing age.

Longitudinal strain has been established as an early predictor of LV systolic dysfunction.[4] In this study there was no correlation between LV function and any of the parameters evaluated, indicating that alterations in these M-mode parameters might indicate subclinical systolic dysfunction.

Nonetheless, although new and more sophisticated techniques to study LV function are appearing, M-mode measures appear to be simpler and faster and can provide values that might be good prognostic markers.

Conclusions

M-mode methods such as MAPSE and especially MMASE appear to be related to global LVLS. Our results demonstrate that subclinical systolic dysfunction can be estimated by simpler and faster methods than strain based on complex speckle analysis.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

Conflicts of interest

The authors have no conflicts of interest to declare.

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