Mitral Annular Plane Systolic Excursion as a Surrogate for Left Ventricular Ejection Fraction in Patients with Impaired Systolic Function

Thesis

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By

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Protocol

Introduction:

Assessment of left ventricular (LV) function is a common indication to perform an echocardiogram. Echocardiographic evaluation of systolic function is important for determination of the hemodynamic status in cardiomyopathy providing data for an informed prognosis and proper treatment. [1, 2]

Assessment of LV function generally requires expert echocardiographer estimation and is somewhat subjective and prone to reader discordance. Despite the routine use of newer and more refined echocardiographic technologies, such as strain-rate imaging, speckle-tracking, and 3D echocardiography, sometimes accurate assessment of LV function might be difficult especially in cases of poor sonographic windows. [3, 4, 5]

Among the factors that affect LV systolic function, contractility plays an important role and depends largely on the function of the myocites, which form the three layers of the equine ventriculum. Several indices are used to assess systolic function; fractional shortening is the most common. Fractional shortening is easily measured and is an indicator of the ventricular myocardium contractile state, especially in relation to the behavior of its short axis. Recent studies have demonstrated the importance of the longitudinal fibers in global myocardial contractility, especially in cardiac patients having alterations in the ventricular geometry and the contractility. [6, 7]

The movement of the mitral annulus toward the apex is a result of long-fiber contraction. During diastole, the annulus moves back away from the apex. LV apical motion is limited throughout the cardiac cycle, such that the distance between the apex of the heart and the chest surface is almost constant during contraction. [8] During systole, the heart produces a displacement of the mitral annulus that is quantitatively related to the intensity of the ventricular contraction. The magnitude of the displacement of the mitral annulus during myocardial contraction can be measured from M-mode images of the mitral annulus. [9, 10]

Mitral annulus is an essential, dynamic, and tightly coupled component of the mitral valve/left atrial/left ventricular complex that aids in effective and efficient valve closure and unimpeded LV filling.[11] The mitral annulus has a complex shape and motion, and its excursion has been correlated to LV function. During the cardiac cycle the annulus excursion encompasses a volume that is part of the total LV volume change during both filling and emptying. [12]

Recent studies suggested that Mitral annular plane systolic excursion (MAPSE) might be helpful as a surrogate measurement for LV function.[13,14] Multiple studies have shown that a decrease in MAPSE correlates with many factors affecting LV function, including atrial fibrillation, myocardial infarction, dilated cardiomyopathy, and age.[15,16] MAPSE, in addition to being a simple surrogate for EF, may have additional implications for patient outcomes. [17, 18, 19] Willenheimer et al. demonstrated that among patients with heart failure, those with decreased MAPSE levels had significantly higher mortality. Previous work done on tricuspid annular systolic excursion has also shown that a simple one-dimensional measurement can predict mortality in patients with heart failure. MAPSE value may be a reliable index of LV systolic function; however, this index has not been used for routine evaluations or as a measurement of systolic dysfunction. [20, 21, 22]

Aim of the work

To validate a previously generated formula to calculate ejection fraction using MAPSE compared with ejection fraction as determined by an expert echo-cardiographer using qualitative eyeball method, m-mode method and biplane modified Simpson's rule in patients with impaired systolic function.

Study Design and Sampling

This is a prospective analysis of 200 patients with systolic dysfunction data by two-dimensional trans-thoracic echocardiography in a single hospital where MAPSE and Ejection Fraction by qualitative eye ball method, m-mode method and biplane modified Simpson's rule will be measured and compared.

Inclusion Criteria:

1. Age > 18 years.
2. Patients able to understand and sign the informed consent document.
3. Patients with impaired systolic function (Ejection Fraction < 50%).

Exclusion Criteria:

1. Patient refuses to perform Echocardiography or to sign the informed consent.
2. Patients who suffer from mitral valve stenosis.
3. Patients with prosthetic mitral valve.
4. Patients who have active infective endocarditis of mitral valve.
5. Patients who have mitral valve leaflet thrombus.
6. Patients with rapid atrial fibrillation.
7. Patients with mod to severe mitral regurgitation.

Methods:

Every patient will be subjected to the following;

I. Baseline assessment:

- Informed consent.
- Thorough history taking and clinical examination including demographics, cardiovascular risk factors, weight, height and vital signs.
- 12 lead ECG.

II. Echocardiographic assessment:

Echocardiography will be performed with the patients in the left lateral decubitus position. Measurements will be performed according to the recommendations of the American Society of Echocardiography. [23] Two-dimensional imaging examination will be performed in the standard fashion in parasternal long and short axis views and apical 4- and 2-chamber views. Pulsed Doppler spectral recordings will be obtained in the apical 4-chamber view from a 4mm sample volume placed at the tips of mitral valve.

Echocardiograms will be subjected to careful visual analysis to detect regional contractile abnormalities. LV systolic and diastolic volumes and ejection fraction will be derived from biplane apical (2- and 4-chamber) views using the modified Simpson's rule algorithm and estimation of ejection fraction by m-mode in parasternal long and short axis. [24] The trans-mitral pulsed Doppler velocity recordings from three consecutive cardiac cycles will be used to derive measurements as follows: peak velocities reached in early diastole (E) and after atrial contraction (A), and deceleration time (DT) is the interval from E-wave to the decline of velocity to baseline. In those cases in which velocity will not return to baseline, extrapolation of the deceleration signal will be performed.

Displacement of the mitral annulus will be measured by Starting in an apical four-chamber view; measurements are done with M-mode beam positioned on the medial and lateral mitral annuli, in line with the left ventricular long axis. Maximum systolic plane excursion of the medial and lateral mitral annuli will be measured in mm. The longitudinal motion of the mitral annulus is depicted over time as a sine wave. The nadir of the sine wave corresponds to the mitral annular position at end-diastole, and the peak occurs at end-systole. The height of the peak relative to the nadir is MAPSE. In the current study, medial and lateral

MAPSE measurements will be taken and averaged for each patient. Inter observer and intra observer variability in MAPSE measurements will be tested in a sub study of patients by an independent observer, as well as re-measuring MAPSE by a single observer. Results obtained from MAPSE measurements will be used to produce calculated ejection fraction on the basis of the formula previously generated by Matos et al. where EF equals for men= 4.8 x MAPSE (mm) + 5.8 and for women= 4.2 x MAPSE (mm) + 20. [25]

Statistics:

Continuous normally distributed data will be analyzed using unpaired t tests and will be presented as mean + SD. Diagnostic properties (sensitivity, specificity, positive predictive value, negative predictive values, and total accuracy) will be calculated according to the MAPSE calibration cohort cutoff values on the basis of gender-specific regression equations previously generated by Matos et al. Two-tailed tests of significance will be reported and P values < .05 will be considered a priori to indicate statistical significance.

Inter-observer and intra-observer variability in MAPSE measurements will be tested by having 20 random studies read by an independent observer, as well as re-measuring MAPSE by a single observer.

Inter-observer variability will be calculated by averaging the values obtained and then dividing the absolute difference between the two observers’ measurements by the mean of the two measurements for every single patient from the randomly selected group. Similarly, intra-observer variability will be calculated from the difference between the two measurements by the same reader.

ALL DATA WILL BE GATHERED, TABULATED, AND STATISTICALLY ANALYZED ON A PC COMPUTER USING A COMMERCIALLY AVAILABLE STATISTICAL SOFTWARE PACKAGE.

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مقدمة:

ان تقييم وظيفة البطين الايسر هو هدف متعارف عليه في عمل الموجات فوق الصوتية على عضلة القلب. تقييم الوظيفة الانقباضية مهم لتحديد الكفاءة فى حالات ضعف عضلة القلب من اجل توفير بيانات و معلومات عن مدى تقدم الحالة او تدهورها والمعالجة السليمة لها. [1,2]

تقدير كفاءة عضلة القلب عادة ما يحتاج الى تقدير خبير فى الموجات الصوتية و فى بعض الاحيان عرضة للتفاوت من خبير لاخر. و على الرغم من استخدام أحدث وأكثر التكنولوجيات فى الموجات فوق الصوتية ، مثل تصوير معدل الجهد ، تتبع النقاط بالموجات فوق الصوتية و الموجات فوق الصوتية ثلاثية الابعاد لتقييم الوظيفة الانقباضية لعضلة القلب ، و لكن احيانا التقييم الدقيق لكفاءة عضلة القلب قد يكون صعب وخاصة فى حالة عدم وضوح الصورة. [3,4,5]

ومن العوامل التى تؤثر على الوظيفة الانقباضية للبطين الايسر و تعتمد الى حد كبير عليها هى وظيفة الخلايا العضلية للقلب ، التى تشكل الطبقات الثلاث للبطين. وهناك عدة مؤشرات تستخدم لتقييم الوظيفة الانقباضية; الاكثر شيوعا هو قياس التقصير الجزئى ، وهو مؤشر قياس للحالة الانقباضية لعضلة البطين بالقلب ، وخاصة فيما يتعلق بسلوك عضلة القلب فى محورها القصير.و لكن هناك دراسات اخيرة اظهرت اهمية الالياف الطولية فى تقييم انقباض عضلة القلب ككل ، وخاصة فى مرضى القلب حيث يعانون من تغير فى شكل و طريقة انقباض البطين. [6.7]

ان الحركة الحلقية للصمام المترالى هى نتيجة انقباض الالياف الطولية. اثناء انبساط عضلة القلب، تكون الحركة الحلقية للصمام المترالى بعيدا عن قمة البطين الايسر . حركة قمة عضلة القلب محدودة طوال الدورة القلبية ، بحيث تكون المسافة بين قمة القلب و سطح الصدر تقريبا ثابتة اثناء الانقباض. [8] انقباض عضلة القلب ينتج عنه حركة لحلقة الصمام المترالى تتناسب طرديا مع شدة انقباض البطين. حجم حركة حلقة الصمام المترالى اثناء انقباض عضلة القلب يمكن قياسها من خلال تصويرها بالموجات الصوتية فى وضع-م . [9,10]

حلقة الصمام المترالى هى مكون ضروري و ديناميكى و ذو صلة وثيقة بكل من الصمام الترالى ،الاذين الايسر و البطين الايسر التى تساعد على اغلاق الصمام المترالى و ملء البطين الايسر بكفاءة و فاعلية. [11] حلقة الصمام المترالى لها شكل و حركة معقدة ، وقد تم ربط حركة الحلقة بوظيفة البطين الايسر. اثناء الدورة القلبية حركة حلقة الصمام المترالى تمثل جزء من مجموع تغير حجم البطين الايسرخلال تعبيئه بالدم وإفراغه. [12]

الدراسات الحديثة افادت ان حركة حلقة الصمام المترالى قد تكون ذو فائدة كبديل لقياس كفاءة عضلة القلب. [13,14] و هناك عدة دراسات اظهرت ان انخفاض مستوى حركة حلقة الصمام المترالى تتلازم مع عوامل كثيرة تؤثر على وظيفة و كفاءة البطين الايسر منها الذبذبة الاذينية ، جلطة القلب ، ضعف عضلة القلب و تقدم العمر. [15,16]

ان الحركة الحلقية للصمام المترالى بالاضافة الى انها بديل لقياس كفاءة عضلة القلب ، فقد يكون لها اثار و نتائج اضافية على المرضى. [17,18,19] ويلينهيمر واخرون ، اوضحوا ان من ضمن المرضى المصابين بضعف عضلة القلب، و الذين لديهم انخفاض فى مستويات الحركة الحلقية للصمام المترالى فان هذا له مؤشر واضح لارتفاع معدل الوفيات لدى هؤلاء المرضى. رحلة العمل على قياس الحركة الحلقية للصمام الثلاثى بينت ان قياس واحد بسيط يمكن من التنبؤ بالوفاة فى مرضى ضعف عضلة القلب. قيمة قياس الحركة الحلقية للصمام المترالى يمكن ان تعد مؤشر موثوق للوظيفة الانقباضية لعضلة القلب; ولكن هذا المؤشر لم يستخدم بعد كتقييم روتينى او كقياس لاختلال الكفاءة الانقباضية لعضلة القلب. [20,21,22]