COMPARATIVE ECHOCARDIOGRAPHIC METODS IN THE ASSESMENT OF MITRAL STENOSIS SEVERITY

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Keywords: *Mitral stenosis, Proximal isovelocity surface area method, pressure half-time method, planimetry method*

Abstract: *The aim of this study was to compare the accuracy of the proximal isovelocity surface area (PISA) and Doppler pressure half-time methods and planimetry for echocardiografic estimation of the mitral valve area. Methods and results:We studied prospectively 49 patients with rheumatic mitral stenosis(MS),hospitalised in the Emergency County Hopsital Rm Valcea, from dec.2007 to aug.2011 . MVA(mitral valve area) was assessed with the PISA method (MVA pisa), PHT(MVA pht), and planimetry (MVApln) serving as the gold standard method. MVA pisa closely correlated with MVApln (r=0,805 si p<0,0001) while MVApht and AVMpln showed a weaker, but still good correlation(r=0,65 , p<0,0001). Conclusions:MVA calculated with PISA method has a better accuracy than MVA calculated with PHT method, though is time consuming.*

Cuvinte cheie: *Stenoza mitrala, metoda PISA(Proximal isovelocity surface area), metoda PHT (Pressure half – time), metoda planimetrica*

Rezumat: *Scopul acestui studiu a fost sa compare acuratetea ariei valvulare mitrale (AVM) calculate prin metoda PISA si PHT raportata la AVM calculata prin planimetrie. Metode si rezultate: Am studiat prospectiv 49 pacienti cu stenoza mitrala reumatismala internati in Spitalul de Urgenta Rm Valcea in perioada dec.2007-aug.2011) .AVM a fost evaluata cu metoda PISA (AVM pisa), metoda PHT (AVMpht) si planimetrie(AVMpln), servind ca si gold standard. AVM prin metoda PISA se coreleaza foarte bine cu AVM pln (r=0,805 si p<0,0001), in timp ce AVMpht arat o corelatie mai slaba dar inca buna cu AVM calculata prin metoda planimetrica. metoda (r=0,65 si p<0,0001). Concluzii: In evaluarea AVM, metoda PISA are acuratete mai mare decat metoda PHT, desi necesita mai mult timp.*

INTRODUCTION

Mitral stenosis is the most frequent valvular complication of the rheumatic fever which is endemic in developing countries. Mitral stenosis is an important health issue in these countries. Even if the prevalence is low in the industrialized countries, mitral stenosis is an important health issue in the elderly patients. Several echocardiographic techniques have been introduced as means of MVA assessment, two of which, the two-dimensional planimetry and pressure half-time (PHT) methods are currently the most widely used.

The PHT method, in particular has gained widespread acceptance for MVA calculations, mainly because of its simplicity and acceptable reproducibility.

PISA method (Proximal Isovelocity Surface Area) was introduced as a new technique to evaluate (MVA).(9)(10).This technique is based on the principles of the continuity equation and the preservation of the mass.The main advantage of the PISA method is its close correlation with reference methods in all studies. This advantage is outweighed, however, by being a dificcult and time consuming technique, which has made PISA the least popular for the calculation of MVA.

THE AIM OF THE STUDY

The objective of this study was to test the hypothesis that PISA method is a better alternative to determine MVA than planimetry. (Planimetry is considered gold standard in the assessment of mitral stenosis severity).

MATERIAL AND METHOD

Population A series of 50 patients with rheumatic mitral stenosis hospitalized in the Cardiology Department of Emergency County Hospital Rm.Valcea, from December 2007 to August 2011, were prospectively enrolled in this study.

The patients who have prior history of percutaneous balloon mitral valvuloplasty were excluded. One patient was excluded from the study (2%) because of the suboptimal images from poor echocardiografic windows.

All patients gave informed consent consistent with this protocol.

Echocardiography

All echocardiographic studies were acquired with a 2.5 MHz multi-frequency phased array transducer (Siemens).
LV ejection fraction was assessed using biplane Simpson` rule, the peak and mean transvalvular pressure gradients were calculated with the modified Bernoulli equation.
All measurements were made in 3 consecutive cardiac cycles and in 5 cycles if the patient`rhythm was atrial fibrillation

Assesment of mitral valve area (MVA)

1. The planimetry method

The smallest orifice of the mitral valve was identified by scanning from left atrium in the direction of the LV apex using basal LV short axis view.The gain settings were adjusted until the lowest level was determined, at which the

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circumference of the orifice was in early diastole. MVA determined by planimetric tecqnique was considered as reference method in this study.

The severity of MS measured with MVA planimetry, as well as MVA PISA or MVA PHT was defined as: mild if MVA was more than 1.5cm² , moderate if MVA was more 1.0 less than or equal to 1.5 cm²,and severe if MA was less than or equal to 1.0cm².(11).

2. The pressure half-time method

MVA determined with the PHT method was calculated in the apical four-chamber view using continous wave Doppler (CWD), to trace the mitral inflow wave.

MVA was calculated using the equation:

MVA pht =220/PHT.

3. The proximal isovelocity surface area method

MVA PISA was obtained in the apical four-chamber view using the equation:

$$MVA\ PISA = 2\ \pi r^2 x\ (Val/Vmax)x(\alpha/180).$$

Aliasing velocity was selected to the frequency of 33cm/s. The α angle is the mitral valve angle and is automatically measured.

Statistical analysis

All data were analysed as mean ± SD.Correlation analyses were performed using linear progression and expressed as Pearson correlation coefficients. All the analyses were performed with commercially available software (SPSS version Inc.Chicago, IL, USA)

RESULTS

The study group consisted of 49 patients with mitral stenosis for each of whom three complete sets of MVA calculations were obtained. (Planimetry, PHT, PISA).20(40.8%) of patients were male and 29 (59.2%) were female.

The mean age was 58.16 years, the maximum age was 74 and the minimum age was 49 years.

Twenty two patients (44.9%) were in chronic atrial fibrillation and 27 (55.1%) were in sinus rhythm.

All patients had normal LV ejection fraction of 61.1 ± 5.9.

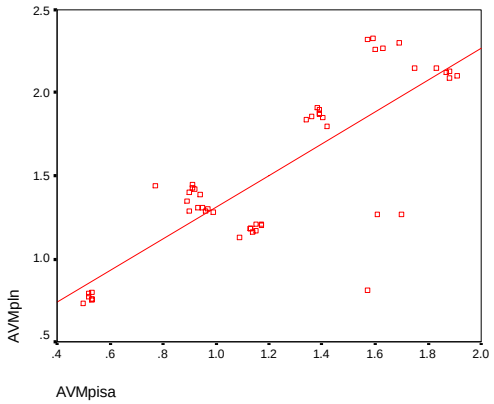
Thirty four patients were in NYHA 1(69.4%) and 15 were in NYHA 3(30.6%).Sixteen patients were classified as mild MS (12.2%) 29 patients (59.2%) as moderate and 14(28.6%) as severe.

None of the patients had severe MS.14 (28.6%) patients had mild aortic regurgitation and 22 (44.9%) had moderate aortic regurgitation.

Correlations between different methods

Linear regression analysis showed that MVA PISA correlated closely with MVA pln (r=0.805,p<0.0001)(Figure 1).

Figure no. 1. Correlation between AVM pisa si AVM pln



A lower, but, good and statistically significant correlation was also found between MVA pln and MVA pht.(r=0.65,P<0.0001). Table 1

Table no. 1. Correlation between AVMpln, AVMpisa and AVMpht

		AVMpln	AVMpht	AVMpisa
AVMpln	Pearson Correlation	1.000	.442**	.805**
	Sig. (2-tailed)	.	.001	.000
	N	49	49	49
AVMpht	Pearson Correlation	.442**	1.000	.450**
	Sig. (2-tailed)	.001	.	.001
	N	49	49	49
AVMpisa	Pearson Correlation	.805**	.450**	1.000
	Sig. (2-tailed)	.000	.001	.
	N	49	49	49

DISCUSSIONS

MVA pln, determined as gold standard in our study is actually not the true gold standard for MVA calculation in the clinical settings, since it is difficult to obtain MVA in a significant number of patients because poor image quality, asymmetrical affection of leaflets, funnel-shaped structures or severe calcifications, therefore, an alternative should be there when any of these conditions is encountered.

There are studies in the literature that showed PHT is an inaccurate measure of MVA if MS is associated with tachycardia, atrial fibrillation, nonlinear Doppler velocity curves, pregnancy or more importantly changes in atrial or ventricular compliance.

Differences between PHT and planimetry of more than 0.3cm² have been found in 20% of patients.On the other hand, PISA method has been validated in almost all conditions that tend to render the PHT inaccurate.

Our study demonstrated that both MVA PISA and MVA PHT correlated well with MVA pln. (r=0.805,r=0.65).

Given the simplicity of the PHT method compared with the technically difficult PISA technique, it seems that PHT has an advantage over PISA.

Study limitations

The number of patients enrolled in this study was limited.

Altough we used the planimetry method as the gold standard,it has some limitations in that it may be influenced by severe leaflet or subvalvular calcification, asymmetrical leaflet affection,imaging technique or poor image quality.

Newly developed imaging modalities, such as three-dimensional echocardiography, magnetic resonance imaging or computed tomography may reduce the operator dependence of the planimetry method and overcome most of its limitations.

CONCLUSIONS

The PISA method is recommended rather than the PHT method for measuring MVA for patients with mitral stenosis because its accuracy is better than the PHT method, although PISA technique is time consuming.

BIBLIOGRAPHY

1. Iung B, Baron G, Buchart EG, Delahaye F,Gohle –Barwolf C, Levang OW et al.A prospective survey of patients with valvular heart diease in Europe : the Euro Heart survey on valvular heart disease .Eur heart J 2003;24;1231-43
2. Faletra F, Pezzano AJ, Fusco R, Mantero A, Corno R,Crivellaro W et al. Measurement of mitral valve area in mitral stenosis four echocardiographic methods compared with direct measurement of anatomic orifices.J Am Coll cardiol 1996;28:1190-7

3. Nakatani S, Masuyama T, Kodama K, Kitabatake A, Fujii K, Kamada T. Value and limitations of Doppler echocardiography in the quantification of stenotic mitral valve area : comparison of the pressure half time and the continuity equation methods.Circulation 1988;77:78-85
4. Rifkin RD, Harper K, Tighe D.Comparison of proximal isovelocity surface area method with pressure –half time and planimetry in evaluation of mitral stenosis .j Am COLL Cardiol1995;26:458-65
5. Hatle L, Angelson B, Tromsdal A .Noninvazive assessement of atrioventricular pressure half-time by Doppler ultrasound .Circulation 1979 ;60: 1096-104
6. Flachskampf FA, Weyman AE, Gillam L ,Liu CM.Aortic regurgitation shortens Doppler pressure half –time in mitral stenosis :clinical evidence in vitrosimulation and theoretic analysis J Am Coll Cardiol 1990;16: 396-404
7. Kim HK, KINYj, chang Sa, Kim DH, Oh B Impact of cardiac rhythm on mitral valve area calculated by pressure-half time in patients with moderate or severe mitral stenosis.j AM Soc Echocardiogr 2009;22:42-7
8. Mohan JC, Muherjee S, Kumar A, Arrora R, Patel AR , Pandian NG.Does chronic mitral regurgitation influence Doppler pressure half-time –derived calculation of mitral valve area in patients with mitral stenosis ?Am Heart J 2004;148:703-9
9. Rodriguez L, Thomas JD, Monterroso V, Weiman AE, Harrigan P et al. Validation of the proximal flow convergence method .Circulation 1993;88:1157-65
10. Deng YB, Matsumoto M, Wang XF, et al. Estimation of mitral vale area in patients with mitral stenosis by the flow convergence region method; selection of aliasing velocity .J Am Coll Cardiol 1994 ;24:683-9
11. Baumgartner H, Evangelista A,Hung J,Otto M.Echocardiogrophic assessement of valve stenosis:EAE/ASE recommendations for clinical practice .Eur J Echocardiogr 2009;10:1-25
12. Ikawa, H, Enya E, Hirano Y, Uehara H, et al.Can the proximal isovelocity surface area method calculate stenotic mitral valve area in patients with associated moderate to sever aortic rewgurgitation ? Analysing using low aliasing velocity of 10% of the peak transmitral velocity .Echocardiography2001;18:89-95