VALUE OF PREOPERATIVE REAL TIME 3D-TEE IN AFFECTING INTENSIVE CARE OUTCOMES POST MITRAL VALVE REPAIR

Hassan G Ali[1], Ashraf W Andraos[2], Mohamed O Hussein[3], Osama E Abdel-Moneim[4], Amira M Ismail[5].

Article History: Received: 15.05.2023 **Revised:** 25.06.2023 **Accepted:** 01.07.2023

Abstract:

Background and Aim: Transesophageal echocardiography (TEE) can visually display the structure and blood flow of the heart, and it is an important method in evaluating the cardiac function and hemodynamic status during the preoperative period.

This study aims to establish the feasibility of using real time 3 D echo in mitral valve repair surgery and compare its finding with those of 2D findings in intensive care unit.

Subjects and methods: We selected 40 patients undergoing elective MV repair. Detailed history, physical examination, resting ECG, conventional 2D, 3D echocardiography assessment, and follow up of other ICU parameters were collected.

Results: This study enrolled 40 patients undergoing elective MV repair. There was a statistically significant difference in between the two groups regarding to ICU stay, duration of mechanical ventilation., LABS abnormalities in ICU, ECG Abnormalities in ICU and result of mitral repair.

Conclusion: The combined application by 2D and 3D TEE may also efficiently guide clinical surgical procedures, enhance patient surgical outcomes, and lower the likelihood of complications in ICU.

Keywords: Mitral regurgitation, 3D Echocardiography, Transesophageal echocardiography, Valve repair surgery.

1. National Heart institute, Cairo, Egypt.
2. Professor of Critical Care Faculty of Medicine, Cairo University.
3. Professor of Cardiology National Heart Institute.
4. Professor of Cardio-throacic Surgery National Heart Institute.
5. Lecturer of Critical Care Faculty of Medicine, Cairo University.

DOI: 10.48047/ecb/2023.12.9.158

Introduction:

The frequency of mitral valve (MV) repair has increased in recent years due to the advancement of surgical techniques. Surgical MV repair is the method of choice for the treatment of most cases of mitral regurgitation (MR) (1).

A detailed preoperative echocardiographic examination of the mitral valve anatomy is imperative for proper planning and satisfactory outcome of surgery and postsurgical period in intensive care unit. Real time 3D trans-esophageal echocardiography (RT-3D-TEE) is a mode of echo which is recently introduced and considered a beneficial tool for pre, intra and post operative assessment of cardiac diseases (2).

Rt-3DTEE helps to acquire images in a more precise and effective manner in comparison to its 2D counterpart. (3)

From this point we start aiming at achieving better outcomes of both surgery and post-surgical period in intensive care unit.

Patients and Methods:

This study was conducted at Cairo university hospitals and Egyptian National Heart Institute (NHI), using a cohort prospective study. The study protocol was approved by the Ethical Committee of faculty of medicine, Cairo university

This study enrolled 40 patients undergoing elective MV repair were included in the current study.

Inclusion criteria: Patients with moderate to severe MR (111-1V/1V), either primary or 2ndry MR (ischemic or non-ischemic), symptomatic (NYHA class111-1V), undergoing elective MV repair and without any other valvular surgery except for functional TR. **Exclusion criteria:** Patient with isolated mitral stenosis, patient with mild MR, asymptomatic patient, patient prepared for mitral valve replacement, urgent MV surgeries and MV repair with other valvular surgeries except for functional TR.

Detailed history, physical examination, resting ECG, conventional 2D, 3D echocardiography assessment, and follow up of other ICU parameters were collected.

Patients with an established diagnosis of moderate to severe MR scheduled for MV repair after obtaining their written informed consent and after approval by the local ethics committee is divided in

to 2groups, one subjected to acomprehensive2D–TEE examination only and 2n done subjected to acomprehensive2D–TEE examination, subsequently followed by 3DTEE assessment
Using Standard views recommended by society of cardiovascular anesthesiologists/American society of echocardiography SCA/ASE guidelines (4). (Basal short axis trans gastric view, mid esophageal (ME)4and5 chamber(ch) views, ME commissural view, ME2-chview) as per recommendation of Lambert et al (5). with an additional of ME long axis view (LAX). Then we assessed each segment of MV as normal or pathological in 2D followed by 3D-TEE with the same manner.
2D and RT-3DTEE findings is compared to the surgical finding in the two groups after surgical exposure which is considered the gold standard for evaluation of the pathology involved.
Follow up other ICU parameter including (time to weaning, need of cardiac support, blood transfusion, renal function, ECG, incidence of complications and time to discharge) to compare the results in both group of the study.

Statistical analysis:
The obtained data were analyzed and graphically represented using Graph Pad Prism program version (8.0.1) for windows. Chi-square χ^2 test, Student t test, Fischer exact test, Welch's correction T test and one way ANOVA test were used to determine the statistical significance of differences between two groups. All data were tested with Kolmogorov- Smirnov Z test and so presented with means ± standard deviation (SD), P value < 0.05 was considered significantly different.

Results:
This study enrolled 40 patients undergoing elective MV repair were included in the current study. the mean age in group 1 was 37.6 years, the mean age in group 2 was 31.3 years with non-significant difference in between (p=**0.303**). In group 1 there was female predominance (80%), while in group 2 there was male predominance (60%) with a significant difference in between (p=0.009) as in table 1

Table (1). Distribution of the studied patients according to demographic data

	3D and 2D-TEE(Group 1) (N= 20)				(N= 20)2dTEE (Group 2)				T test*	P value
	Maximum	Minimum	Means	SD	Maximum	Minimum	Means	SD		
Age (years)	44	32	37.6	7.89	45	16	31.3	10.17	t=1.058	0.303 NS
Gender	N		%		N		%		X^2**	P value
Male	4		20 %		12		60 %		6.666 FE	0.009 S
Female	16		80 %		8		40 %			

* Statistically significant difference (p< 0.05).

Table 2 showed that the mean time of mechanical ventilation in group 1 was **8.2** while in group 2 was **11.6** with a significant difference in between (P=0.041).

Table (2): Comparison between two groups regarding time of mechanical ventilation

	3D and 2D-TEE (Group 1) (N= 20)		**2dTEE (Group 2) (N= 20)**		**T test (Student t-test)**	**P value**
	Means	**SD**	**Means**	**SD**		
Time of Mechanical Ventiliation	**8.2**	**3.03**	**11.6**	**2.06**	**t=3.43**	**0.041***

* Statistically significant difference (p< 0.05).

Table 3 showed showed that there was a high statistically significant difference in between the two groups regarding to post operative result of MR BY TTE with p=0.000.

The most common post operative result of MR BY TTE in group 1 was trivial MR and in group 2 was trivial MR(VC<3mm) . While there was 2 cases with severe MR in group 2(*VC >7 mm) ,there was no one had severe MR in group 1.

Table (3): Comparison of Post operative Result of MR BY TTE analysis between two groups between two groups.

		3D and 2D-TEE(Group 1) (N= 20)		**2dTEE (Group 2) (N= 20)**		**χ^2 Chi square test (Fisher Exact)**	**P value**
Post operative Result of MR BY TTE		**N**	**%**	**N**	**%**		
Post operative Result of MR by TTE(VC* based)	trivial MR	12	60%	6	30%	30.0 FE	0.000**
	mild MR	4	20%	4	20%		
	moderate MR	2	10%	2	10%		
	severe MR	0	0	2	10%		
	no	2	10%	6	30%		

** Highly Statistically significant difference ($p< 0.05$).

Fig 1 showed that there was a high statistically significant difference in between the two groups regarding to ECG Abnormalities in ICU with p=0.000
.

The most common ECG Abnormalities in ICU in group 1 was SVT and in group 2 was SVT and nodal rhythm

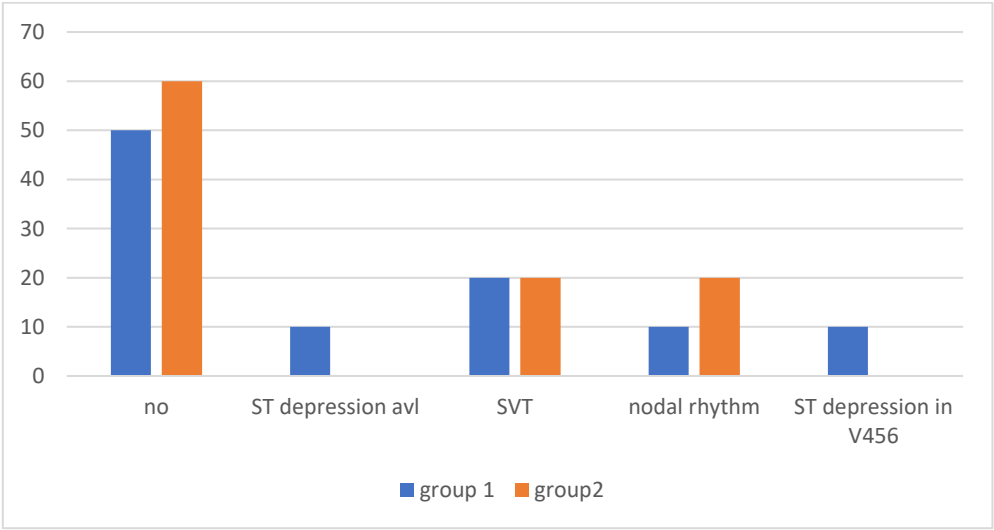

Fig 1: Comparison of ECG Abnormalities in ICU between two groups

Table 4 showed that there was a high statistically significant difference in between the two groups regarding to LABS Abnormalities in ICU with p=0.000. There was 70% in group 1 had no LABS Abnormalities in ICU, and 60% in group 2 had no LABS Abnormalities in ICU.

Table (4): Comparison of LABS Abnormalities in ICU between two groups**.**

		3D group(Group 1) (N= 20)		2D group (Group 2) (N= 20)		χ^2 Chi square test (Fisher Exact)	P value
LABS Abnormalities in ICU		**N**	**%**	**N**	**%**		
LAB abnormalities in ICU	no	14	7**0** %	12	6**0** %	34.58 FE	0.000**
	HB drop	2	1**0** %	4	20%		
	ALT rising	2	1**0** %	0	0		
	CREAT. rising	2	**10** %	0	0		
	WBC s rising	0	**0**	2	**10** %		
	AST rising	0	0	2	**10** %		

**Highly Statistically significant difference ($p< 0.05$).

Discussion:

The mean aim of the current study was to establish the feasibility of using real time 3 D echo in MV surgery and compare its finding with those of 2D findings in intensive care unit. In the current study, the most common pathology in 3D and 2D-TEE (Group 1) was A2 prolapse while in 2DTEE (Group 2) was p2 prolapse. **Xie et al., (6)** stated that compared with the 2-dimensional technique, both static and dynamic 3-dimensional echocardiography provides more information about cardiac anatomic structures without any arbitrary geometric assumptions.

In 2014 **Ben Zekry et al. (7)** demonstrated that all four imaging modalities (2D TTE, 2D TEE, RT 3D TTE, and 3D TEE) were comparable in identifying MR etiology, but 3D TEE had the best agreement with surgery in the identification of anterior leaflet prolapse and bileaflet or multisegmental prolapse.

In the present study, there was a high statistically significant difference in between the two groups regarding to Post operative Result of MR BY TTE, our results agree with the study done by **Mukherjee et al., (8)** who found that RT-3D-TEE is feasible in patients undergoing elective mitral valve repair. Several studies in the past showed the benefits of using 3D echocardiography for assessment of the mitral valve morphology (9-11).

In our study, the most common post operative result of MR BY TTE in 3D and 2D-TEE (Group 1) was trivial MR and in 2dTEE (Group 2) was trivial MR. Although MV repair is the procedure of choice for patients with mitral valve prolapse, residual mitral regurgitation is associated with poor long-term outcome **(12)**. Hence it is imperative to have an optimal repair, since MV replacement is considered to have worse long-term outcomes in intensive care unit (13-14).

Using TEE 3D technology, **Veronesi et al. (15)** described the mitro-aortic physiology and coupling in 24 patients with normal LV ejection fraction and normal mitral and aortic valves. For the first time, using custom software, no invasive mitro-aortic coupling (MAC) could be evaluated. As expected, annular mitral and aortic area changed reciprocally during the cardiac cycle (pusatility) as well as the mitro-aortic angle which decreased during systole, probably playing a significant role in cardiac performance. Further studies by the same group tested the impact of mitral valve surgical procedure (repair with ring implantation) in the MAC dynamics by assessing the influence of such a surgery on the normal aortic valve **(16)**.

Grewal et al. (17) also found that RT 3D-TEE provides new insights that allow the refining of mitral pathophysiology concepts and repair strategies. Also, **Ma et al. (18)** found that Live 3D-TEE enabled evaluation of MV function and provided adequate valuable information before and after MV surgery.

Pan et al. (19) in their study found that RT-3DTEE is a unique new modality for rapid and accurate evaluation of MV prolapse and MV repair.In the study done by **Guo et al. (20)** who evaluated the utility of 2D and 3D-TEE to assess MV coaptation before and after MV repair, found that both 2D and 3D variables may complement each other for aiding MV repair. 2D CLI is an alternative to 3D CAI due to its simplicity.

In 2010, **Assudani et al. (21)** presented a case in whom 3D TEE allowed a more confident diagnosis of caseous MAC, compared with 2D echocardiography and 3D TTE. 3D TEE revealed an echodense mass involving the posterior MA,

and a relatively less echogenic area characterized by multiple, small echodensities surrounded by highly echogenic borders, consistent with regions of calcific granules interspersed in a liquefied substance.

Indeed, **Tamborini et al. (22)** found that complex prolapses, undergoing complex procedures, had twice the percentage of residual MR ≥2 after MV surgical repair vs. simple MV lesions undergoing simple procedures. Favorable cardiac remodeling, observed in all cases at 6-months followup, was maintained at 3 years only when MR was <2.

Conclusion:

The combined application by 2D and 3D TEE may also efficiently guide clinical surgical procedures, enhance patient surgical outcomes, and lower the likelihood of complications in ICU.

Conflict of interest:
NIL.
Source of funding:
NIL.

Individual author's contribution:

Hassan G Ali: Whole work of the study.

Ashraf W Andraos: Continuous supervision on whole work and guidance of selection of cases and broad instructions.

References:

1- Seeburger J, Borger MA, Doll N, Walther T, Passage J, Falk V, Mohr FW. Comparison of outcomes of minimally invasive mitral valve surgery for posterior, anterior and bileaflet prolapse. European journal of cardio-thoracic surgery. 2009 Sep 1;36(3):532-8.

2- Veronesi F, Corsi C, Sugeng L, Mor-Avi V, Caiani EG, Weinert L, Lamberti C, Lang RM. A study of functional anatomy of aortic-mitral valve coupling using 3D matrix transesophageal echocardiography. Circulation: Cardiovascular Imaging. 2009 Jan;2(1):24-31.

3- Pepi M, Tamborini G, Maltagliati A, Galli CA, Sisillo E, Salvi L, Naliato M, Porqueddu M, Parolari A, Zanobini M, Alamanni F. Head-to-head comparison of two-and three-dimensional transthoracic and transesophageal echocardiography in the localization of mitral valve prolapse. Journal of the American College of Cardiology. 2006 Dec 19;48(12):2524-30.

4- Shanewise JS, Cheung AT, Aronson S, Stewart WJ, Weiss RL, Mark JB, Savage RM, Sears-Rogan P, Mathew JP, Quiñones MA, Cahalan MK. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination: recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography. Journal of the American Society of Echocardiography. 1999 Oct 1;12(10):884-900.

5- Lambert AS, Miller JP, Merrick SH, Schiller NB, Foster E, Muhiudeen-Russell I, Cahalan MK. Improved evaluation of the location and mechanism of mitral valve regurgitation with a systematic transesophageal echocardiography examination. Anesthesia & Analgesia. 1999 Jun 1;88(6):1205-12.

6- Xie MX, Wang XF, Cheng TO, Wang J, Lu Q. Comparison of accuracy of mitral valve area in mitral stenosis by real-time, three-dimensional echocardiography versus two-dimensional echocardiography versus Doppler pressure half-time. The American journal of cardiology. 2005 Jun 15;95(12):1496-9.

7- Ben Zekry S, Jain S, Alexander SK, Li Y, Aggarwal A, Jajoo A, Little SH, Lawrie GM, Azencott R, Zoghbi WA. Novel parameters of global and regional mitral annulus geometry in man: comparison between normals and organic mitral regurgitation, before and after mitral valve repair. European Heart Journal–Cardiovascular Imaging. 2016 Apr 1;17(4):447-57.

8- Mukherjee C, Tschernich H, Kaisers UX, Eibel S, Seeburger J, Ender J. Real-time three-dimensional echocardiographic assessment of mitral valve: Is it really superior to 2D transesophageal echocardiography?. Annals of Cardiac Anaesthesia. 2011 May 1;14(2):91.

9- Manda J, Kesanolla SK, Hsuing MC, Nanda NC, Abo-Salem E, Dutta R, Laney CA, Wei J, Chang CY, Tsai SK, Hansalia S. Comparison of real time two-dimensional with live/real time three-dimensional transesophageal echocardiography in the evaluation of mitral valve prolapse and chordae rupture. Echocardiography. 2008 Nov;25(10):1131-7.

10- Hirata K, Pulerwitz T, Sciacca R, Otsuka R, Oe Y, Fujikura K, Oe H, Hozumi T, Yoshiyama M, Yoshikawa J, Di Tullio M. Clinical utility of new real time three-dimensional transthoracic echocardiography in assessment of mitral valve prolapse. Echocardiography. 2008 May;25(5):482-8.

11- Kronzon I, Sugeng L, Perk G, Hirsh D, Weinert L, Garcia Fernandez MA, Lang RM. Real-time 3-dimensional transesophageal echocardiography in the evaluation of post-operative mitral annuloplasty ring and prosthetic valve dehiscence. Journal of the American College of Cardiology. 2009 Apr 28;53(17):1543-7.

12- Suri RM, Schaff HV, Dearani JA, Sundt III TM, Daly RC, Mullany CJ, Enriquez-Sarano M, Orszulak TA. Survival advantage and improved durability of mitral repair for leaflet prolapse subsets in the current era. The Annuals of thoracic surgery. 2006 Sep 1;82(3):819-26.

13- Thourani VH, Weintraub WS, Guyton RA, Jones EL, Williams WH, Elkabbani S, Craver

JM. Outcomes and long-term survival for patients undergoing mitral valve repair versus replacement: effect of age and concomitant coronary artery bypass grafting. Circulation. 2003 Jul 22;108(3):298-304.

14- Gammie JS, Sheng S, Griffith BP, Peterson ED, Rankin JS, O'Brien SM, Brown JM. Trends in mitral valve surgery in the United States: results from the Society of Thoracic Surgeons Adult Cardiac Database. The Annals of thoracic surgery. 2009 May 1;87(5):1431-9.

15- Veronesi F, Corsi C, Sugeng L, Mor-Avi V, Caiani EG, Weinert L, Lamberti C, Lang RM. A study of functional anatomy of aortic-mitral valve coupling using 3D matrix transesophageal echocardiography. Circulation: Cardiovascular Imaging. 2009 Jan;2(1):24-31.

16- Veronesi F, Caiani EG, Sugeng L, Fusini L, Tamborini G, Alamanni F, Pepi M, Lang RM. Effect of mitral valve repair on mitral-aortic coupling: a real-time three-dimensional transesophageal echocardiography study. Journal of the American Society of Echocardiography. 2012 May 1;25(5):524-31.

17- Grewal J, Suri R, Mankad S, Tanaka A, Mahoney DW, Schaff HV, Miller FA, Enriquez-Sarano M. Mitral annular dynamics in myxomatous valve disease: new insights with real-time 3-dimensional echocardiography. Circulation. 2010 Mar 30;121(12):1423-31.

18- Ma N, Li ZA, Meng X, Yang Y. Live three-dimensional transesophageal echocardiography in mitral valve surgery. Chinese medical journal. 2008 Oct 20;121(20):2037-41.

19- Pan C, Shu XH, Cao Q, Wang C, Ding W, Chen H. Role of real-time three-dimensional transesophageal echocardiography in mitral valve repair. J Geriatr Cardiol. 2008 Sep 28;5:137-41.

20- Guo Y, He Y, Zhang Y, Ge S, Sun L, Liu W, Han J, Gu X. Assessment of the mitral valve coaptation zone with 2D and 3D transesophageal echocardiography before and after mitral valve repair. Journal of thoracic disease. 2018 Jan;10(1):283.

21- Assudani J, Singh B, Samar A, Pannu J, Singh A, Nabavizadeh F, Singh P, Sunkavalli KK, Nanda NC. Live/real time three-dimensional transesophageal echocardiographic findings in caseous mitral annular calcification. Echocardiography. 2010 Oct;27(9):1147-50.

22-Tamborini G, Mantegazza V, Penso M, Muratori M, Fusini L, Ghulam Ali S, Cefalù C, Italiano G, Volpato V, Gripari P, Caiani EG. Predictive value of pre-operative 2D and 3D transthoracic echocardiography in patients undergoing mitral valve repair: Long term follow up of mitral valve regurgitation recurrence and heart chamber remodeling. Journal of Cardiovascular Development and Disease. 2020 Oct 20;7(4):46.