doi: 10.13241/j.cnki.pmb.2018.14.019

实时三维经胸超声心动图检测二尖瓣成形术前后左心房功能的变化及临床意义 *

王 翔[1] 王灵通[2] 胡志强[3] 黄小伟[1] 朱英娟[1] 曹 新[1]

（1 江苏无锡明慈心血管病医院超声科 江苏 无锡 214000；2 山东中医药大学附属医院特检科 山东 济南 250011；
3 浙江大学医学院附属第一医院 浙江 杭州 310000）

摘要 目的：探讨实时三维经胸超声心动图检测左心房(LA)功能以评价二尖瓣成形术(MVR)疗效的价值。**方法：**选择 87 例二尖瓣关闭不全患者(病例组)分别在 MVR 术前及术后 1 w、24 w 采取实时三维经胸超声心动图检测 LA 的最大容积(maximum volume of LA, LAV_{max})、最小容积(the minimum volume of LA, LAV_{min})、收缩前容积(systolic volume, LAV_p)及射血分数(ejection fraction, LAEF)、被动射血分数(passive ejection fraction, LAPEF)及主动射血分数(active ejection fraction, LAAEF)等指标，并与同期 80 例健康志愿者作对照。**结果：**病例组术前 $LAV_{max}I$、$LAV_{min}I$、LAV_pI、LAEF、LAPEF、LAAEF 值与对照组比较差异有统计学意义($P<0.05$)，术后 1 w、24 w，$LAV_{max}I$、$LAV_{min}I$、LAV_pI、LAEF、LAPEF 持续改善($P<0.05$)，LAPEF 无明显变化($P>0.05$)。术后 24 w，LA 严重扩张由术前 58.6 %降低到 12.6 %，67.8 %发生 LA 重构。**结论：**实时三维经胸超声心动图显示 MVR 术后 LA 容积与功能好转，对评价 MVR 的疗效有一定价值。

关键词：三维；超声心动图；二尖瓣成形术；左心房

中图分类号：R654.2；R540.45 **文献标识码：**A **文章编号：**1673-6273(2018)14-2692-04

Detection of the Changes of Left Ventricular Function before and after Mitral Valvuloplasty by Real Time Three Dimensional Transthoracic Echocardiography and Its Clinical Significances*

WANG Xiang[1], WANG Ling-tong[2], HU Zhi-qiang[3], HUANG Xiao-wei[1], ZHU Ying-juan[1], CAO Xin[1]

(1 Department of Ultrasound, Wuxi Mingci Institute of Cardiovascular Diseases, Wuxi, Jiangsu, 214000, China; 2 Special Laboratory Department, Affiliated hospital of Shandong University of Traditional Chinese Medicine, Ji'nan, Shandong, 250011, China; 3 First Affiliated Hospital of Zhejiang University School of Medicine, Hangzhou, Zhejiang, 310000, China)

ABSTRACT Objective: To evaluate the clinical value of real-time three-dimensional transthoracic echocardiography for detecting the left atrium (LA) function in mitral valvuloplasty (MVR). **Methods:** The maximum volume of LA(LAV_{max}), minimum volume(LAV_{min}), systolic volume(LAV_p) and ejection fraction(LAEF), passive ejection fraction(LAPEF) and active ejection fraction(LAAEF) of 87 cases of patients with mitral regurgitation (case group) were examined by real time three-dimensional transthoracic echocardiography respectively before and at 1 week and 24 weeks after MVR, and compared with 80 healthy volunteers in the same period. **Results:** The preoperative $LAV_{max}I$, $LAV_{min}I$, LAV_pI, LAEF, LAPEF and LAAEF values between the case group and the control group were statistically significant ($P<0.05$), the $LAV_{max}I$, $LAV_{min}I$, LAV_pI, LAEF and LAPEF values from MVR 1w to 24w were continuously improvement ($P<0.05$), while the LAPEF values showed no obvious change ($P>0.05$). At 24 weeks postoperation, the proportion of severe LA dilatation decreased from 58.6 % to 12.6 %, and LA remodeling was found 67.8 % cases. **Conclusions:** Real time three-dimensional transthoracic echocardiography showed LA volume and functional improvement after MVR, which was of some value in evaluating the curative effect of MVR.

Key words: Three dimensional; Echocardiography; Mitral valvuloplasty; Left atrium

Chinese Library Classification(CLC): R654.2; R540.45 Document code: A

Article ID: 1673-6273(2018)14-2692-04

前言

近年，二尖瓣修补术(MVR)已开展于二尖瓣退行性变、缺血性二尖瓣反流、风湿性二尖瓣病变等致二尖瓣关闭不全的治疗，手术成功率可达 95 %[1,2]。MVR 保留了二尖瓣瓣叶及瓣下结构的正常解剖，保护了左心室(LV)收缩功能，而左心房(LA)与左心室的形态功能变化相一致[3,4]，前者能够调节后者的充盈，对维持心搏量的正常十分重要[5]。近年研究表明 LA 容积与

* 基金项目：山东省教育厅科研基金项目(J121ko09)

作者简介：王翔(1980-)，男，硕士，主治医师，研究方向：超声诊断，E-mail: wangxiang_1980@papmedhos.top

(收稿日期：2017-10-10 接受日期：2017-10-31)

功能的准确评估有助于预测心房颤动、心衰及猝死等发生风险，其主要受到压力负荷及容量的影响，压力负荷增加常见于左心室舒张、收缩功能障碍或二尖瓣狭窄，而容量负荷增加多见于心脏高输出状态、左向右分流或二尖瓣反流等，从而导致左心室灌注压增大[6,7]。LA 具有"管道功能"、"存储功能"，管道功能取决于左心室舒张功能，储存功能取决于 LA 壁的顺应性，LA 前负荷取决于 LA 心肌收缩力、后负荷等，由于 LA 形态不规则，二维超声在显示 LA 形态及功能变化上的能力欠佳，测量 LA 舒张末期前后径时不能反映 LA 容积变化。实时三维超声心动图能完整显示 LA 三维立体结构，不会因为利用几何形状假设而导致计算上的误差，更接近心脏的真实容积[8,9]。本研究主要通过实时三维经胸超声心动图检测 LA 功能变化以评价 MVR 的疗效，现将结果报道如下。

1 资料与方法

1.1 一般资料

收集我院 2016 年 9 月到 2017 年 5 月因二尖瓣关闭不全而行 MVR 治疗的 87 例患者作为病例组，男 57 例，女 30 例，年龄 16~72 岁，平均(47.4± 8.5)岁，NYHA 心功能Ⅱ级 19 例，Ⅲ级 41 例，Ⅳ级 27 例，均行人工二尖瓣环植入，其中 33 例加做矩形切除瓣叶，18 例加做人工腱索成形术，15 例加做后叶折叠。另选取同期 80 例健康志愿者作为对照组，男 44 例，女 36 例，年龄 18~70 岁，平均(48.3± 10.4)岁。受试者均对本研究知情同意。

1.2 仪器与方法

Philips iE33 型彩色多普勒超声诊断仪，配有 S5-1 探头(2.0~3.5 MHz) 采集二维图像及组织多普勒超声图像，以及 X3-1 三维矩阵探头 (1~5 MHz) 可进行全容积 RT3DE 图像采集，配有 Qlab 定量分析软件。先取心尖四腔、心尖两腔、心尖左心室长轴观 3~5 个心动周期的二维图像，然后切换成 X3-1 三维矩阵探头，在标准四腔心切面采集左心房三维图像。导入工作站用 Qlab 软件定量分析软件对二维和三维图像进行分析。测量参数：① 二维超声心动图：左心房最大前后径(LAD)、舒张末期左心室前后径(LVDd)、左心室射血分数(LVEF)。② 三维超声心动图 LV 容积参数：最大容积(LAV_{max})[LAV_{max}≥ 40 mL/m^2 为 LA 严重扩张，LAV_{max} 减小≥ 15 %为 LA 重构 [3]、最小容积(LAV_{min})、收缩前容积(LAVp)，为减小人群身材大小的影响，均经体表面积(BSA)校正为 $LAV_{max}I$、$LAV_{min}I$、LAV_pI；LV 功能参数：射血分数(LAEF)、被动射血分数(LAPEF)及主动射血分数(LAAEF)，LAEF= [(LAV_{max}-LAV_{min})/LAV_{max}] × 100；LAPEF= [(LAV_{max}- LAV_p)/LAV_{max}] × 100；LAAEF= [(LAVp-LAV_{min})/LAVp]× 100，由软件自动完成计算。各参数连续测量 3 次取平均值。分别在术前及术后 1 w、24 w 检查一次。

1.3 统计学分析

应用 SPSS 13.0 统计软件进行数据分析，计量资料以均值± 标准差($\bar{x}$± s)表示，组间比较采用 t 检验，计数资料用百分比(%)表示，组间比较采用卡方检验(x^2)，以 P<0.05 为差异具有统计学意义。

2 结果

2.1 两组经二维超声心动图测定的左心房(室)大小及功能参数比较

病例组术前 LAD、LVDd 值明显大于对照组 (P＜0.05)，LVEF 值与对照组比较差异无统计学意义(P＞0.05)；术后 1 w，LAD、LVDd 值明显较术前明显降低(P＜0.05)，仍明显高于对照组(P＜0.05)；术后 24 w，LAD、LVDd 值较术后 1 w 进一步降低(P＜0.05)，与对照组比较差异无统计学意义(P＞0.05)；术前后 LVEF 值比较差异均无统计学意义(P＞0.05)，见表 1。

表 1 两组左心房(室)大小及功能参数的比较

Table 1 Comparison of the left atrial (ventricular) size and functional parameters between two groups

Group	LAD(mm)	LVDd(mm)	LVEF(%)
Control group(n=80)	34.71± 12.33	48.26± 10.05	65.20± 12.19
Case group(n=87)			
Preoperation	53.21± 12.13*	62.45± 11.35*	62.64± 15.48
At 1 week postoperation	44.09± 10.24*△	54.93± 9.55*△	61.96± 14.59
At 24 week postoperation	37.12± 11.62#	50.96± 9.72#	63.77± 10.31

Note: compared with the control group, *P<0.05; compared with preoperation, △ P<0.05; compared with 1 week postoperation, #P<0.05.

2.2 两组经三维超声心动图测定的左心房各容积参数比较

病例组术前 $LAV_{max}I$、$LAV_{min}I$、LAV_pI 值明显大于对照组(P＜0.05)，LAEF、LAPEF、LAAEF 值明显小于对照组 (P＜0.05)；术后 1w，$LAV_{max}I$、$LAV_{min}I$、LAV_pI 值较术前明显降低(P＜0.05)，LAEF、LAPEF 值明显升高(P＜0.05)，与对照组比较差异仍有统计学意义(P＜0.05)；术后 24 w，$LAV_{max}I$、$LAV_{min}I$、LAV_pI、LAEF 较术后 1 w 进一步改善(P＜0.05)，与对照组比较差异无统计学意义(P＞0.05)，LAPEF 与术后 1 w 比较差异无统计学意义(P＞0.05)，与对照组比较差异仍有统计学意义(P＜0.05)；术后 LAAEF 无明显变化，与对照组比较差异均有统计学意义(P＜0.05)。见表 2。

2.3 术前及术后 24 wLA 严重扩张、LA 重构情况

术后 24 w，LA_{max}≥ 40 mL/m^2 由术前 58.6 %(51/87) 降低到 12.6 %(11/87)，67.8 %(59/87)的 LAV_{max} 减小≥ 15 %。

3 讨论

二尖瓣关闭不全时，LA 功能受损早于 LV，肺静脉回流及二尖瓣反流血液会使 LA 的容量增加，LA 显著扩张，而持续容量负荷增加可使左心室壁顺应性降低，舒张功能受损，进一步造成 LA 的压力负荷增加以及左心房壁扩张[10,11]。因此，评价 LA 功能变化有利于早期知道心功能的损伤情况[12]。

表 2 两组经三维超声心动图测定的左心房左心房各容积参数比较

Table 2 Comparison of the volume parameters of left atrium and left atrium measured by three-dimensional echocardiography between two groups

Group	$LAV_{max}I$ (mL/m^2)	$LAV_{min}I$ (mL/m^2)	LAV_pI (mL/m^2)	LAEF (%)	LAPEF (%)	LAAEF (%)
Control group (n=80)	22.61± 6.74	8.73± 3.39	14.09± 4.58	60.38± 13.61	39.74± 8.11	35.22± 9.84
Case group(n=87)						
Preoperation	43.51± 7.25*	22.41± 6.39*	33.67± 9.55*	47.89± 10.37*	29.01± 9.47*	25.33± 7.59*
At 1 week postoperation	34.66± 8.46*△	14.51± 5.19*△	21.27± 5.83*△	53.80± 13.20*△	33.14± 9.64*△	27.69± 9.77*
At 24 week postoperation	24.51± 7.31#	9.93± 4.72#	16.92± 6.24#	58.28± 10.94#	34.96± 10.59*	28.39± 7.90*

Note: compared with the control group, *P<0.05; compared with the preoperation, △ P<0.05; compared with 1 week postoperation, #P<0.05.

LA 功能参数是根据 LA 容积计算而出的,所以测量 LA 容积是获知 LA 功能的先决条件[13,14]。目前可用于测量 LA 容积的技术方法不止一种,如血管造影、核素扫描、超声等,但前两种技术存在辐射伤害、有创操作、分辨率低、费用昂贵等问题[15,16]。二维超声心动图通过双平面几何假设方法来实现 LA 容积的计算,但心脏是一个三维结构,这种二维几何假设结果有一定的误差,测量 LA 舒张末期前后径无法准确反映 LA 容积变化[17,18]。而实时三维经胸超声心动图能够实时通过三维容积测量,不依赖于几何假设,能够准确地反映 LA 的瞬时容积,较二维超声更准确可靠[19]。研究表明其与心脏磁共振(CMR)显著相关(r=0.88)[6],故而在此基础上能够准确显示 MVR 术前后的 LA 改变,为评价 LA 功能变化及 MVR 疗效提供详细的信息[20,21]。

过去常用二尖瓣反流量、LV 功能来判断 MVR 疗效,但中重度二尖瓣反流的患者易高估 LVEF,从而导致无法准确判断其心功能损伤程度[22]。二尖瓣反流的程度、持续时间及病情程度决定着 LA 容积如何变化[23]。MVR 术前患者的 LA 容积参数 $LAV_{max}I$、$LAV_{min}I$、LAV_pI 均大于健康者,而在术后早期呈明显的减小趋势,接近正常人水平,LA 严重扩张的比例明显降低,可见房室内径扩大是可逆的[24]。MVR 术通过置入人工二尖瓣环减少了二尖瓣反流量,降低了 LV 灌注压,从而促使 LA 容积缩小。陈昕等[25]研究表明 LAV_{max} 与二尖瓣跨瓣压差呈负相关。MVR 术前患者的 LAEF、LAPEF、LAAEF 明显小于健康者。Okamatsu K 等 [8] 亦发现 LV 舒张功能受损的患者 LAPEF 与 LAAEF 较正常人减小。在 MVR 术后早期 LAPEF 明显增加,其原因与 MVR 术后 LV 容量负荷降低,LV 壁顺应性改善,LV 舒张功能好转有关。术前后的 LAAEF 变化不明显,改善程度不如 LAPEF,从理论上讲,MVR 术可减少 LA 前、后负荷,改善 LA 心肌收缩力,从而使 LAAEF 明显增加[26,27],但可能是因为部分患者的年龄大,病程长,LA 壁顺应性较差 [28],LA 压力负荷严重,导致心肌纤维化,使心肌收缩力严重损伤,所以不见 LAAEF 有明显好转[29,30],提示 MVR 不可延误,对于满足手术指征的患者手术越早越好。

综上所述,实时三维经胸超声心动图简便易行、无伤害,适用于术后跟踪疗效,能够准确测量 LA 容积及功能,对评价 MVR 疗效具有一定价值,值得进一步随访验证远期疗效。

参 考 文 献(References)

[1] Elsayed M, Bulur S, Kalla A, et al. Incremental value of live/real time three-dimensional transesophageal echocardiography over the two-dimensional technique in the assessment of aortic atherosclerotic thrombi and ulcers[J]. Echocardiography, 2016, 33(8): 1234

[2] Kemaloğlu ÖT, Elsayed M, Nanda N C, et al. Incremental value of live/real time three-dimensional transesophageal echocardiography over the two-dimensional technique in the assessment of a tuberculoma involving the left atrium and appendage [J]. Echocardiography, 2016, 33(9): 1409-1412

[3] İnci S, Erol M K, Bakırcı E M, et al. Effect of percutaneous mitral balloon valvuloplasty on right ventricular functions in mitral stenosis: Short- and mid-term results [J]. Anatolian Journal of Cardiology, 2015, 15(4): 289-296

[4] Kumar G A, Parimala P S, Jayaranganath M, et al. Three-dimensional Transesophageal Echocardiography-guided Transcathetar Closure of Ruptured Noncoronary Sinus of Valsalva Aneurysm [J]. Annals of Cardiac Anaesthesia, 2017, 20(Suppl 1): S73-S75

[5] Caro-Codón J, López-Fernández T, Bermejo Z B, et al. Three-dimensional transesophageal echocardiography in the diagnosis of biological prosthetic valve thrombosis (and its resolution)[J]. Revista Portuguesa De Cardiologia, 2016, 35(2): 127-129

[6] Jurinjak S J, Vincelj J, Pušić M S, et al. The role of two- and three-dimensional transesophageal echocardiography in the treatment of patients with patent foramen ovale [J]. Cardiologia Croatica, 2017, 12(4): 156

[7] Arisha M J, Hsiung M C, Ahmad A, et al. Incremental benefit of three-dimensional transesophageal echocardiography in the assessment of left main coronary artery stent protrusion [J]. Echocardiography, 2017, 34(6): 915-918

[8] Taenaka H, Imada T, Abe R, et al. Right ventricular functional assessment by three-dimensional transesophageal echocardiography is useful for withdrawal from a right ventricular assist device: a case report [J]. Ja Clinical Reports, 2017, 3(1): 40

[9] Zhou, Qing, Song, et al. Roles of real-time three-dimensional transesophageal echocardiography in peri-operation of tran scatheter left atrial appendage closure[J]. Medicine, 2017, 96(4): e5637

[10] Kettering K, Gramley F, Bardeleben S V. Catheter ablation of atrial fibrillation facilitated by preprocedural three-dimensional transesophageal echocardiography: Long-term outcome [J]. World Journal of Cardiology, 2017, 9(6): 539-546

[11] Deng Y, Guo S, Su H, et al. Left atrial asynchrony and mechanical function in patients with mitral stenosis before and immediately after percutaneous balloon mitral valvuloplasty: A real time three-dimensional echocardiography study [J]. Echocardiography, 2015, 32(2): 291-301

[12] Bektaş O, Günaydin Z Y, Karagöz A, et al. Evaluation of the effect of percutaneous mitral balloon valvuloplasty on left ventricular systolic function via strain and strain rate in patients with isolated rheumatic mitral stenosis [J]. Journal of Heart Valve Disease, 2015, 24(2): 204-209

[13] Bhaya M, Sudhakar S, Sadat K, et al. Effects of antegrade versus integrated blood cardioplegia on left ventricular function evaluated by echocardiographic real-time 3-dimensional speckle tracking[J]. Journal of Thoracic & Cardiovascular Surgery, 2015, 149(3): 877-884

[14] Morttada A, Elfiky A, Onsy A, et al. Echocardiographic effect of successful balloon mitral valvuloplasty on right ventricular function[J]. Egyptian Heart Journal, 2015, 67(1): 33-39

[15] Velasco O, Beckett M Q, James A W, et al. Real-time three-dimensional echocardiography: Characterization of cardiac anatomy and function-current clinical applications and literature review update[J]. Bioresearch Open Access, 2017, 6(1): 15-18

[16] Avsar S, Keskin M, Velibey Y, et al. Incremental utility of real time three-dimensional transthoracic echocardiography for the assessment of left ventricular free wall rupture location, orifice geometry, and complex intracardiac flow [J]. Echocardiography, 2015, 32(11): 1738-1741

[17] Esposito R, Badano L P, Muraru D, et al. Tricuspid valve morphology and function evaluated by transthoracic real-time three-dimensional echocardiography[J]. Giornale Italiano Di Cardiologia, 2015, 11(7-8): 549-556

[18] Mizukoshi K, Takeuchi M, Nagata Y, et al. Normal Values of Left Ventricular Mass Index Assessed by Transthoracic Three-Dimensional Echocardiography[J]. Journal of the American Society of Echocardiography, 2016, 29(1): 51-61

[19] Zhou X, Thavendiranathan P, Chen Y, et al. Feasibility of automated three-dimensional rotational mechanics by real-time volume transthoracic echocardiography: Preliminary accuracy and reproducibility data compared with cardiovascular magnetic resonance [J]. Journal of the American Society of Echocardiography Official Publication of the American Society of Echocardiography, 2016, 29(1): 62-73

[20] Prastaro M, D'Amore C, Paolillo S, et al. Prognostic role of transthoracic echocardiography in patients affected by heart failure and reduced ejection fraction [J]. Heart Failure Reviews, 2015, 20(3): 305-316

[21] Rifaie O, Abdel-Rahman M A, Samir S, et al. Worsening of left ventricular twist mechanics in isolated rheumatic mitral stenosis immediately after balloon mitral valvuloplasty [J]. Egyptian Heart Journal, 2016, 68(2): 69-74

[22] Mori M, Yoshimuta T, Ohira M, et al. Impact of real-time three-dimensional transesophageal echocardiography on procedural success for mitral valve repair [J]. Journal of Echocardiography, 2015, 13(3): 1-7

[23] Francis L, Finley A, Hessami W. Use of three-dimensional transesophageal echocardiography to evaluate mitral valve morphology for risk stratification prior to mitral valvuloplasty [J]. Echocardiography, 2017, 34(2): 303-305

[24] Gürbüz A S. 2 in 1 mitral insufficiency: Diagnosis established with real-time three-dimensional transesophageal echocardiography [J]. Kosuyolu Heart Journal, 2015, 18(2): 105-106

[25] Berdejo J, Shiota M, Mihara H, et al. Vena contracta analysis by color Doppler three-dimensional transesophageal echocardiography shows geometrical differences between prolapse and pseudoprolapse in eccentric mitral regurgitation [J]. Echocardiography, 2017, 34(5): 683-689

[26] Nistri S, Ballo P, Mele D, et al. Effect of echocardiographic grading of left ventricular diastolic dysfunction by different classifications in primary care [J]. American Journal of Cardiology, 2015, 116(7): 1144-1152

[27] Rathakrisnnan S S, Ramasamy R, Kaliappan T, et al. Immediate outcome of balloon mitral valvuloplasty with JOMIVA balloon during pregnancy [J]. Journal of Clinical & Diagnostic Research Jcdr, 2017, 11(2): OC18-OC20

[28] Yuan X, Zhou A, Li C, et al. Diagnosis of mitral valve cleft using real-time 3-dimensional echocardiography[J]. Journal of Thoracic Disease, 2017, 9(1): 159-165

[29] Gopalakrishnan A, Ganapathi S, Sivasubramonian S, et al. Partial papillary muscle rupture following percutaneous mitral valvuloplasty without mitral regurgitation [J]. Journal of Echocardiography, 2016, 14(2): 1-2

[30] Fierro M A, Welsby I J. Identification of Severe Mitral Stenosis Using Real-Time Three-Dimensional Transesophageal Echocardiography During an Left Ventricular Assist Device Insertion [J]. Anesthesia & Analgesia, 2016, 123(5): 1089

(上接第 2704 页)

[27] Lee E M , Choi M H , Seo H S , et al. Impact of vasomotion type on prognosis of coronary artery spasm induced by acetylcholine provocation test of left coronary artery [J]. Atherosclerosis, 2017, 25(7): 195-200

[28] Patel A V, Bangalore S. Challenges with Evidence-Based Management of Stable Ischemic Heart Disease[J]. Current cardiology reports, 2017, 19(2): 11

[29] Adams A, Bojara W, Schunk K. Early Diagnosis and Treatment of Coronary Heart Disease in Symptomatic Subjects with Advanced Vascular Atherosclerosis of the Carotid Artery (Type III and IV b Findings Using Ultrasound)[J]. Cardiology research, 2017, 8(1): 7-12

[30] Kureshi F, Shafiq A, Arnold S V, et al. The prevalence and management of angina among patients with chronic coronary artery disease across US outpatient cardiology practices: insights from the Angina Prevalence and Provider Evaluation of Angina Relief (APPEAR)study [J]. Clinical cardiology, 2017, 40(1): 6-10