医工结合研究专题

二维斑点追踪技术评价的不同类型完全左束支传导阻滞预测心脏再同步化治疗患者急性反应的价值

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摘　要: 目的　探讨二维斑点追踪技术(2D-STE)评价的不同类型完全左束支传导阻滞(CLBBB)预测接受心脏再同步化治疗(CRT)的慢性充血性心力衰竭(CHF)患者急性反应的临床价值。**方法**　选取36例接受CRT的CHF合并CLBBB患者, 分别在CRT关闭和开启状态接受超声心动图检查,并将CRT开启时左室射血分数(LVEF)增加≥5%设为有反应, <5%设为无反应。根据左室后室间隔纵向时间-应变曲线类型,将CLBBB分为Ⅰ型、Ⅱ型、Ⅲ型。将Ⅰ型和Ⅱ型设为研究组1, Ⅲ型设为研究组2, 在CRT关闭状态下测量常规超声参数、收缩功能参数、收缩不同步参数。**结果**　36例患者中,有反应者为29例(80.56%), 无反应者为7例(19.44%); CLBBB Ⅰ型患者20例, Ⅱ型4例, Ⅲ型12例。研究组1有22例患者CRT急性反应有效,应答有效率为91.67%(22/24); 研究组2有7例患者CRT急性反应有效,应答有效率为58.33%(7/12); 研究组1患者CRT急性反应的应答有效率高于研究组2患者,差异有统计学意义($P<0.05$)。2组患者的左室内径、左室收缩功能、左室舒张功能、室间不同步参数比较,差异无统计学意义($P>0.05$)。研究组1的室间隔整体纵向峰值应变、侧壁整体纵向峰值应变均小于研究组2, 差异有统计学意义($P<0.05$)。研究组1的左室18节段峰值应变达峰时间的标准差大于研究组2, 差异有统计学意义($P<0.05$)。**结论**　不同类型CLBBB急性反应的应答有效率有差异; CLBBB Ⅰ、Ⅱ型急性反应的应答有效率优于CLBBB Ⅲ型; CLBBB Ⅰ、Ⅱ型室间隔及左室侧壁功能优于CLBBB Ⅲ型; CLBBB Ⅰ、Ⅱ型左室内收缩不同步性较CLBBB Ⅲ型显著。

关键词: 心脏再同步化治疗; 二维斑点追踪技术; 急性反应; 完全左束支传导阻滞; 室间隔纵向应变; 左室侧壁纵向应变

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Value of different patterns of complete left bundle branch block evaluated by two-dimensional speckle tracing echocardiography in predicting acute response of patients with cardiac resynchronization therapy

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Abstract: Objective　To explore the clinical value of different patterns of complete left bundle branch block (CLBBB) evaluated by two-dimensional speckle tracing echocardiography (2D-STE) in predicting acute response of chronic congestive heart failure (CHF) patients with cardiac resynchronization therapy (CRT). **Methods**　A total of 36 patients with CHF and CLBBB by CRT were selected and conducted with echocardiography examination in the ON and OFF states of CRT, and the increase of left ventricular ejection fraction (LVEF) ≥5% at ON state of CRT was defined as responsive, while the increase of LVEF <5% was defined as unresponsive. According to the longitudinal time-strain curve types of left ventricular posterior interventricular septum, CLBBB was divided into type Ⅰ, type Ⅱ and type Ⅲ. Patients with type Ⅰ and type Ⅱ were set as study group 1, patients with

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type Ⅲ were set as study group 2, and the conventional ultrasound parameters, systolic function parameters and systolic asynchrony parameters were detected at the OFF state of CRT. **Results** Among the 36 patients, there were 29 cases (80.56%) with response and 7 cases (19.44%) without response; there were 20 patients with type Ⅰ CLBBB, 4 patients with type Ⅱ, and 12 patients with type Ⅲ. There were 22 patients with effective response to acute response of CRT in the study group 1, and the effective rate of response was 91.67% (22/24); in the study group 2, 7 patients had effective response to acute response of CRT, and the effective rate of response was 58.3% (7/12); the effective rate of response to acute response of CRT in the study group 1 was significantly higher than that in the study group 2 ($P<0.05$). There were no significant differences in left ventricular diameter, left ventricular systolic function, left ventricular diastolic function and ventricular asynchrony parameters between the two groups ($P>0.05$). The overall longitudinal peak strain of the interventricular septum and the overall longitudinal peak strain of the lateral wall in the study group 1 were significantly lower than those in the study group 2 ($P<0.05$). The standard deviation of the peak time of left ventricular strain at 18 segments in the study group 1 was significantly greater than that in the study group 2 ($P<0.05$). **Conclusion** There are differences in response efficiency of acute response among different types of CLBBB; the response efficiency of acute response in type Ⅰ and Ⅱ CLBBB is better than that of type Ⅲ CLBBB; the function of interventricular septum and left ventricular sidewall in type Ⅰ and Ⅱ CLBBB is better than that of type Ⅲ CLBBB; the left ventricular systolic asynchrony of type Ⅰ and Ⅱ CLBBB is more significant than that of type Ⅲ CLBBB.

Key words: cardiac resynchronization therapy; two-dimensional speckle tracing echocardiography; acute response; complete left bundle branch block; longitudinal strain of interventricular septum; longitudinal strain of left ventricular sidewall

心脏再同步化治疗(CRT)是通过心脏的双室起搏技术来纠正、恢复和改善已存在的电机械活动不同步及左室重构,是难治性心力衰竭治疗中的里程碑式的突破[1-4]。多项临床试验[5-8]关注宽QRS的心力衰竭患者,试验结果均表明伴有完全左束支传导阻滞(CLBBB)的宽QRS的心力衰竭患者从CRT治疗中获益最大,因此伴有CLBBB的心力衰竭患者在2013年欧洲心脏病学学会更新的心脏再同步治疗指南中成为了CRT的Ⅰ类适应证。尽管采用了新的适应证,但CRT应答有效率仍未见明显提高[9-10]。MELGAARD J等[11]通过电脑程序模拟出CLBBB的后室间隔的整体纵向时间-应变曲线,揭示了存在不同类型的CLBBB,这或可导致CLBBB患者CRT应答率存在差异。

二维斑点追踪技术(2D-STE)是近年来发展起来的新技术,其不受探头角度影响,可从微观角度通过心肌力学对心肌运动进行分析,多用于心肌纵向、径向及圆周方向的功能评价。纵向应变的敏感性较高且临床应用较为广泛,尤其在心功能降低患者的预后评估中要优于射血分数[12-13]。本研究探讨2D-STE评价的不同类型CLBBB对接受CRT治疗的慢性充血性心力衰竭(CHF)患者急性反应的临床预测价值,现报告如下。

1 资料与方法

1.1 一般资料

回顾性选取2020年1月—2022年3月在中国医科大学附属第一医院接受CRT治疗的36例患者为研究对象,年龄33~86岁,平均(64.33±11.20)岁,男22例,女14例,左室电极均植入冠状静脉窦部左心侧后静脉。纳入标准:① 最佳药物治疗无效者;② 纽约心脏病学会(NYHA)心功能分级Ⅱ、Ⅲ级者;③ 左室射血分数(LVEF)<35%者;④ CLBBB者;⑤ 窦性心律者。排除标准:① 3个月内心肌梗死发作或行冠状动脉搭桥术者;② 心脏瓣膜病者;③ 心房颤动者;④ 先天性心脏病患者;⑤ 肝肾功能不全患者;⑥ 甲状腺功能亢进症患者。

1.2 研究方法

采用超声心动图检查,随机将CRT关闭和开启,每个程序间隔10 min,再次行超声心动图检查,检查结束后将CRT恢复至开启状态。急性反应的判定:分别在CRT关闭和开启状态下接受超声心动图检查,将CRT开启时LVEF增加≥5%设为有反应,<5%设为无反应[5-8]。

1.3　图像采集

采用 GE vivid 7 型超声诊断仪,选用 M4S 探头。所有受试者均采取左侧卧位,连接体表心电图,采集二维胸骨旁左心室长轴切面、左心室短轴切面和心尖四腔及三腔、二腔心切面的 3 个连续心动周期动态图像,采用频谱多普勒测量二尖瓣、左室流出道、右室流出道血流频谱,采用 TDI 频谱测量二尖瓣侧壁瓣环、室间隔瓣环频谱,设置帧频为 60 帧/s, 并妥善储存数据。

1.4　图像分析

将储存的图像导入 EchoPAC 工作站进行脱机分析,手动描记心内膜,选取合适的心肌厚度,尽可能完整地包绕左心室各壁以进行 2D-STE 评估,并根据美国超声心动图学会指南[9]测量下述参数。

1.4.1　常规超声参数: 左心室舒张末期内径(LVEDD)、左心室收缩末期内径(LVESD)、左心室舒张末期容积(LVEDV)、左心室收缩末期容积(LVESV)、左心室每搏量(LVSV)、LVEF、二尖瓣舒张早期血流速度峰值(Mitral E)、二尖瓣舒张晚期血流速度峰值(Mitral A)、二尖瓣 E 峰减速时间(Mitral EDT)、室间隔及二尖瓣左心室侧壁瓣环舒张早期速度峰值的均值(Mitral e′)、心室间机械延迟时间(IVMD)。计算 Mitral E/A 及 Mitral E/e′; IVMD 是指左室流出道射血前期和右室流出道射血前期时间差, 当 IVMD > 40 ms 时,提示左心室与右心室之间存在收缩不同步。

1.4.2　2D-STE 检测左室、左室侧壁及室间隔收缩功能: ① 测量左室总体纵向峰值应变(GLOBAL_OFF), 作为左室整体收缩功能的参数; ② 测量四腔心及三腔心 6 个节段室间隔整体纵向峰值应变(G_Sept_off), 作为室间隔收缩功能参数; ③ 测量四腔心侧壁 3 个节段整体纵向峰值应变(G_Lateral_off), 作为左室侧壁收缩功能参数。

1.4.3　2D-STE 检测左室内收缩不同步参数: ① 左室 18 节段峰值应变和收缩末期应变之差的比值的总和[应变延迟指数(SDI), △% SDI = $\sum n=18(\varepsilon_{peak}-\varepsilon_{ES})$], 其中 ES 为左室收缩末期应变[10]; ② 左室 18 节段峰值应变达峰时间的标准差[11]; ③ 左室径向应变达峰时间差[12]; ④ 左室基底段前间隔与侧壁达峰时间差[14]。以上所有检测值取 3 个心动周期的均值。

1.4.4　CLBBB 分型: 根据后室间隔纵向时间-应变曲线对 CLBBB 进行分型。

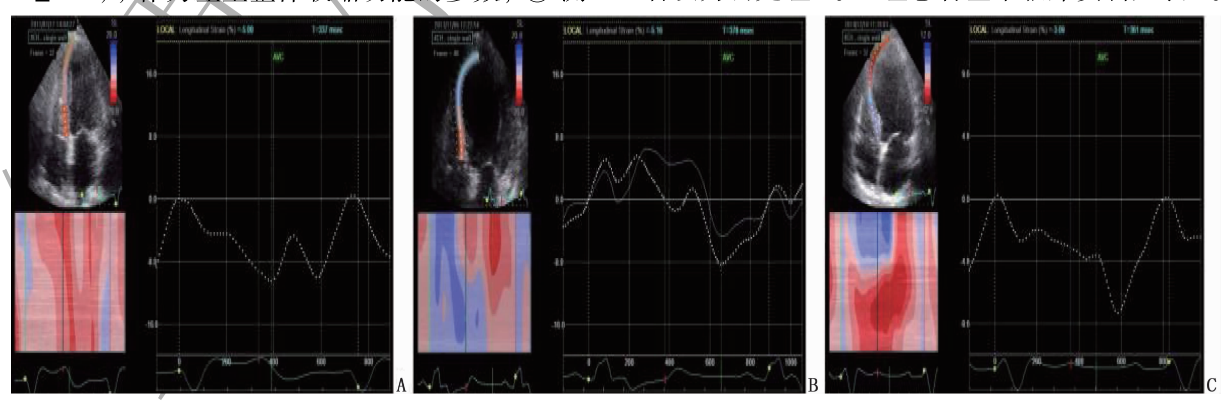
1.5　统计学分析

采用 SPSS 26.0 软件进行数据分析,计数资料[n(%)]比较采用 χ^2 检验,计量资料以($\bar{x} \pm s$)表示,组间比较采用独立样本 t 检验, $P<0.05$ 为差异有统计学意义。

2　结　果

2.1　分组结果

2D-STE 检测左室后室间隔纵向时间-应变曲线类型后,将 36 例患者按 CLBBB 分型分为Ⅰ型 20 例、Ⅱ型 4 例、Ⅲ型 12 例。Ⅰ型是收缩期双峰收缩峰值应变, Ⅱ型是显著的收缩期延展伴随极早期收缩期峰值应变, Ⅲ型是假性正常化的收缩期峰值应变伴随较晚的收缩期真正峰值应变。见图 1。将Ⅰ型和Ⅱ型患者设为研究组 1, Ⅲ型患者设为研究组 2。2 组患者基本临床资料见表 1。



A: Ⅰ型; B: Ⅱ型; C: Ⅲ型。

图 1　CLBBB 分型

2.2　2 组患者 CRT 急性反应的应答有效率比较

研究组 1 有 22 例患者 CRT 急性反应有效,应答有效率为 91.67% (22/24); 研究组 2 有 7 例患者 CRT 急性反应有效,应答有效率为 58.33% (7/12); 研究组 1 患者 CRT 急性反应的应答有效率高于研究组 2 患者,差异有统计学意义($P<0.05$)。

表1 患者基本临床资料($\bar{x} \pm s$)

基本临床资料		研究组1($n=24$)	研究组2($n=12$)
年龄/岁		60.33±14.29	60.01±13.67
性别	男	14(58.33)	8(66.67)
	女	10(41.67)	4(33.33)
体表面积/m^2		1.67± 0.24	1.77± 0.19
QRS/ms		165.00±46.70	162.00±43.52
心率/(次/min)		68.37±10.48	63.89±11.59

2.3 2组患者常规超声参数比较

2组患者常规超声心动图检测的左室内径、左室收缩功能及左室舒张功能、室间不同步参数比较,差异无统计学意义($P>0.05$),见表2。

2.4 2组患者纵向应变参数及左室内收缩不同步参数的比较

研究组1与研究组2的左室总体纵向峰值应变、左室18节段峰值应变和收缩末期应变之差的比值的总和比较,差异无统计学意义($P>0.05$)。研究组1的室间隔整体纵向峰值应变、侧壁整体纵向峰值应变均小于研究组2,差异有统计学意义($P<0.05$)。研究组1与研究组2的左室径向应变达峰时间差、左室基底段前间隔与侧壁达峰时间差比较,差异无统计学意义($P>0.05$);研究组1的左室18节段峰值应变达峰时间的标准差大于研究组2,差异有统计学意义($P<0.05$)。见表3。

表2 2组患者常规超声参数比较($\bar{x} \pm s$)

参数	研究组1($n=24$)	研究组2($n=12$)	P
LVEDD/mm	47.13± 3.37	53.53± 7.70	0.196
LVESD/mm	32.00± 3.21	38.53± 8.37	0.333
LVEDV/mL	82.87±14.99	107.75±35.39	0.788
LVESV/mL	33.00±10.86	44.92±20.38	0.573
LVSV/mL	51.40± 9.16	63.10±17.15	0.522
LVEF/%	62.43± 4.37	59.66± 6.33	0.328
Mitral E/(cm/s)	0.76± 0.16	0.74± 0.23	0.816
Mitral EDT/ms	166.72±32.35	202.14±83.49	0.280
Mitral A/(cm/s)	0.68± 0.13	0.78± 0.23	0.357
Mitral E/A	1.14± 0.03	1.06± 0.69	0.450
Mitral E/e′	7.75± 2.05	12.75± 5.72	0.283
IVMD/ms	44.35±38.61	48.45±33.17	0.531

LVEDD:左心室舒张末期内径;LVESD:左心室收缩末期内径;LVEDV:左心室舒张末期容积;LVESV:左心室收缩末期容积;LVSV:左心室每搏量;LVEF:左室射血分数;Mitral E:二尖瓣舒张早期血流速度峰值;Mitral EDT:二尖瓣E峰减速时间;Mitral A:二尖瓣舒张晚期血流速度峰值;Mitral e′:室间隔及二尖瓣左心室侧壁瓣环舒张早期速度峰值的均值;IVMD:心室间机械延迟时间。

表3 2组患者二维纵向应变参数及左室内收缩不同步参数比较($\bar{x} \pm s$)

参数	研究组1($n=24$)	研究组2($n=12$)
左室总体纵向峰值应变/%	−10.70± 3.56	−9.04± 3.35
室间隔整体纵向峰值应变/%	−23.76± 6.45*	−19.01± 4.90
侧壁整体纵向峰值应变/%	−12.58± 4.16*	−8.43± 3.22
左室18节段峰值应变和收缩末期应变之差的比值的总和/%	0.20± 0.13	0.34± 0.26
左室18节段峰值应变达峰时间的标准差/ms	95.79±26.76*	77.83±21.90
左室径向应变达峰时间差/ms	85.87±92.61	80.00±82.61
左室基底段前间隔与侧壁达峰时间差/ms	85.96±96.87	81.16±76.98

与研究组2比较,$*P<0.05$。

3 讨论

CRT可以提高心力衰竭患者的心功能,改善其症状并降低病死率,其可行性和有效性已被多个大规模临床研究[5-10]验证。但是,既往多中心研究[17-22]证明仍有20%~40%接受CRT治疗的患者的临床症状无明显改善,即CRT无应答。有学者[7,16]提出既往的指南均采用QRS>120 mm的电同步性参数,因而应用机械同步性的参数将提高CRT应答的有效率。目前,超声心动图是评估心脏机械不同步性、预测CRT疗效的重要技术手段之一。然而,近期的多中心临床试验[19-22]结果却未能揭示利用超声心动图各项参数评价的机械不同步性与电不同步性相比之下的优越性,并在可行性及重复性上受到质疑。

2D-STE是在二维超声图像的基础上发展起来的一项新技术,通过测量应变及应变率检测心肌纵向、径向及圆周运动。该技术已在CLBBB患者左心室收缩功能及收缩同步性评估中得到证实。斑点追踪技术与组织多普勒频移无关,因此无角度依赖性,可更全面、准确地评价心肌运动[14-15]。在CLBBB的情况下,异常的室间隔收缩期收缩即延展是由电传导延迟导致的室间隔与左室侧壁的相互作用产生的。SHOMAN K A等[14]通过电脑程序模拟出的不同类型CLBBB的后室间隔的整体纵向时间-应变曲线揭示了室间隔和左室侧壁的收缩功能是产生不同类型CLBBB及不同步程度的决定性因素[15-16]。Ⅰ型缩期双峰收缩峰值应变主要是由CLBBB电传导的延迟导致的机械不同步性引起,Ⅱ型显著的收

缩期延展伴随极早期收缩期峰值应变是由CLBBB电传导的延迟导致的机械不同步性的基础上伴随室间隔的低幅度收缩运动引起，Ⅲ型假性正常化的收缩期峰值应变伴随较晚的收缩期真正峰值应变是由电传导延迟合并降低的左室侧壁收缩运动、伴或不伴有室间隔的低幅度收缩运动而引起[2]。

本研究发现,不同分型的CLBBB的急性反应的应答有效率存在差异,且CLBBB Ⅰ型、Ⅱ型优于CLBBB Ⅲ型。影响反应应答的因素包括左室心肌的存活性及收缩功能、电极部位的植入等。DURAL M等[23]认为,电极位置与电-机械延迟部位越接近, CRT疗效越好。大部分心力衰竭患者的侧壁及后壁是延迟最晚的部位,因此左室电极植入冠静窦部位的左心侧后静脉的效果是最佳的。既往研究[19-22]也揭示侧后壁的瘢痕将大大降低CRT应答有效率。本研究中,所有患者的左室电极均插入左心侧后静脉,然而CRT应答效果却存在显著差异。本研究还发现在不同分型的CLBBB中,通过2D-STE所测量的室间隔及左室侧壁功能有显著差异,且CLBBB Ⅰ型、Ⅱ型室间隔及左室侧壁收缩功能均优于CLBBB Ⅲ型,与CRT急性反应的应答有效率结果相一致。本研究揭示CRT急性反应的应答有效率不仅与电极插入的位置有关,也与左室侧壁及室间隔收缩功能密切相关。

通过2D-STE所测量的左室内收缩不同步参数中,本研究揭示只有左室18节段峰值应变达峰时间的标准差在2组间存在显著差异,且CLBBB Ⅲ型同步性优于Ⅰ型、Ⅱ型。Ⅲ型CLBBB结合了左室室间隔及左室侧壁收缩功能减低,形成了Ⅲ型假性正常化的收缩期峰值应变,这也是Ⅲ型CLBBB同步性优于Ⅰ型、Ⅱ型CLBBB的主要原因[15, 24-26],同时也间接证明了单纯的左室内不同步性参数并不能准确预测CRT反应的应答有效率。

综上所述,对CLBBB进行分型时,左室内收缩同步性和左室侧壁及室间隔收缩功能可作为综合评价指标,这为临床提高CRT应答有效率提供了新的方向。相较于常规超声心动图, 2D-STE具有无创、无角度依赖性等特点,为评价CRT术后患者急性期反应对心脏功能的影响提供了一种新方法,具有较高的应用价值。

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