

二维纵向应变及应变率技术评价室间隔缺损修补术后室间隔功能变化

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【摘要】目的:应用二维斑点追踪技术评价室间隔缺损(VSD)修补术对室间隔局部功能的影响。**方法:**行室间隔修补术的儿童患者38例,于术前1周内、术后1周及术后6个月行超声检查,检测左室射血分数(LVEF)、二尖瓣口舒张早期血流速度(E)/二尖瓣环舒张早期速度(e')、左室整体收缩期纵向应变(LS)及应变率(LSRs)、舒张早期纵向应变率(LSRe)及舒张晚期纵向应变率(LSRa);室间隔心肌收缩期纵向应变(LS_{IVS})及应变率(LSRs_{IVS})、舒张早期纵向应变率(LSRe_{IVS})及舒张晚期纵向应变率(LSRa_{IVS})。同期30例正常儿童作为对照组。**结果:**术前VSD患者E/e'、LS、LSRs、LS_{IVS}及LSRs_{IVS}显著高于对照组($P<0.05$ 或 $P<0.01$),LSRe和LSRe_{IVS}减低($P<0.05$),而LVEF无差异($P>0.05$);修补术后1周,LVEF、LS、LSRs、LSRe、LS_{IVS}、LSRs_{IVS}及LSRe_{IVS}显著小于对照组($P<0.05$ 或 $P<0.01$),而E/e'较对照组增大($P<0.05$);术后6个月,LS_{IVS}、LSRs_{IVS}及LSRe_{IVS}仍显著低于对照组($P<0.05$),其余参数恢复正常。**结论:**VSD修补术后6个月,室间隔局部收缩、舒张功能仍减低;二维斑点追踪技术是准确评价室间隔局部功能的新方法。

【关键词】儿童;先天性心脏病;室间隔缺损;二维斑点追踪;收缩和舒张功能;纵向应变;应变率

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Assessing interventricular septal function after ventricular septal defect repair by using two-dimensional longitudinal strain and strain rate

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Abstract: Objective To evaluate the effect of ventricular septal defect (VSD) repair on the regional function of interventricular septal (IVS) by using two dimensional speckle tracking imaging (2D-STI). **Methods** Totally, 38 patients who need to accept VSD repair were selected in this study. The selected patients were detected by echocardiography within 1 week before VSD repair, 1 week and 6 months after VSD repair. The left ventricular ejection fraction (LVEF), mitral early diastolic velocity/mitral annulus velocity (E/e'), left ventricular systolic longitudinal strain (LS) and strain rate (LSRs), early diastolic longitudinal strain rate (LSRe) and late diastolic longitudinal strain rate (LSRa), LS_{IVS}, LSRs_{IVS}, LSRe_{IVS} and LSRa_{IVS} were measured. And thirty healthy children of the same period were selected as control group. **Results** Before the operation, E/e', LS, LSRs, LS_{IVS} and LSRs_{IVS} of VSD patients were significantly higher than those of healthy children ($P<0.05$ or $P<0.01$); compared with control group, LSRe and LSRe_{IVS} of VSD patients decreased significantly ($P<0.05$); no significant differences were found in LVEF between two groups ($P>0.05$). A week after the operation, LVEF, LS, LSRs, LSRe, LS_{IVS}, LSRs_{IVS} and LSRe_{IVS} of VSD group were significantly lower than those of control group ($P<0.05$ or $P<0.01$), but E/e' of VSD group was significantly higher than that of control group ($P<0.05$). Six months after the operation, the LS_{IVS}, LSRs_{IVS} and LSRe_{IVS} of VSD group were significantly lower than those of the control group ($P<0.05$), while the other parameters of VSD group returned to normal. **Conclusion** Six months after the VSD repair, ventricular regional systolic and diastolic functions are still decreasing. And the 2D-STI is a new method to evaluate IVS regional function exactly.

Key words: children; congenital heart disease; ventricular septal defect; two dimensional speckle tracking imaging; systolic and diastolic function; longitudinal strain; strain rate

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前言

室间隔缺损(Ventricular Septal Defect, VSD)修补术是临床治疗VSD一种常用方法,中、小型VSD修补术后左心室功能特别是室间隔局部功能是否完全恢复,目前研究结果尚存在争议^[1-2]。研究证实二维斑点追踪技术(2D-STI)可以准确反映左室整体及局部功能^[3]。本研究应用2D-STI技术检测左室整体及室间隔二维纵向应变及应变率,探讨VSD修补术对左室整体及室间隔局部功能的影响。

1 材料与方法

1.1 研究对象

选取2012年8月~2015年1月在中国医科大学附属一院拟行VSD修补术的60例儿童患者为病例组。入选标准:年龄<14岁;膜周部VSD;VSD最大径与主动脉根部直径比值小于2/3;窦性心律;左室射血分数(LVEF)>55%^[4];排除肺高压及合并其他系统疾病者。健康儿童30例为对照组。受检儿童父母均签署知情同意书。所有患者在术前1周内(group1)、术后1周(group2)及术后6个月(group3)行超声心动图检查。

1.2 仪器与方法

采用GE Vivid7彩色超声诊断仪,S5-1探头,频率为1~5 MHz,配有Echo PAC11.0工作站。患者左侧卧位,连接心电图,行超声检查,采集胸骨旁左室长轴、心尖两腔、三腔及四腔切面稳定的3个连续心动周期动态图像存储。

1.3 数据分析

VSD大小的测量:多切面测量取最大直径。主动脉根部直径:由左室长轴切面测量3次,取平均值。根据美国超声心动图学会指南^[5],测量以下参数:(1)常规二维超声参数:左室舒张末内径(LVEDD)、收缩末内径(LVESD)、舒张末容积(LVEDV)、收缩末容积(LVESV)及LVEF。(2)多普勒参数:二尖瓣口舒张早期血流速度(E)、舒张晚期血流速度(A)及二尖瓣环舒张早期速度(e'),计算E/A及E/e'。(3)2D-STI参数:采用Echo PAC11.0软件,分析左室心尖四腔、两腔及三腔心切面,检测以下参数:左室整体收缩期纵向应变(LS)、收缩期纵向应变率(LSRs)及舒张早期和舒张晚期纵向应变率(LSR_e and LSR_a);室间隔收缩期纵向应变(LS_{ivs})、收缩期纵向应变率(LSR_{sivs})及舒张早期和晚期纵向应变率(LSR_{eivs} and LSR_{aivs})(图1和图2)。

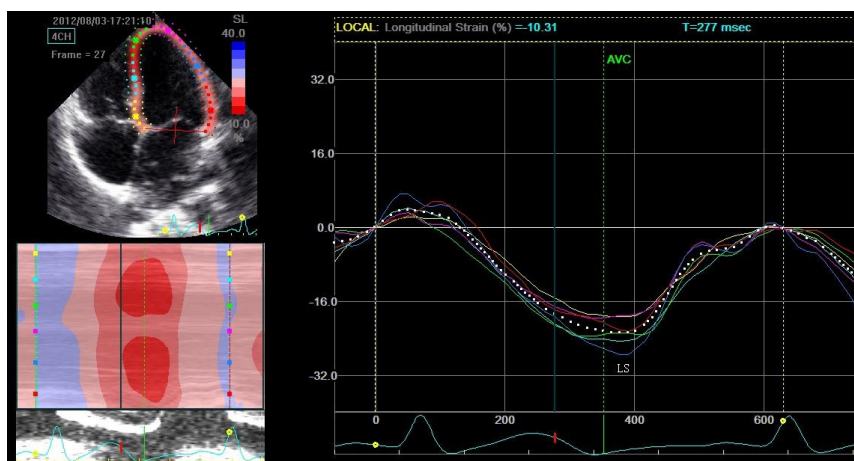


图1 左室纵向应变图

Fig.1 LV longitudinal strain diagram

1.4 重复性分析

随机选择10例图像进行2D-STI参数观察者内及观察者间测量重复性检验。

1.5 统计学方法

采用SPSS 16.0统计软件,计量资料用均数±标准差表示;组间比较采用单因素One-way ANOVA分析, $P<0.05$ 有统计学意义。

2 结果

2.1 一般情况

病例组共38例完成所有随访,VSD大小2.6~7.1 mm,平均 (4.7 ± 1.5) mm;VSD分流峰速为4.1~4.7 m/s;VSD最大径/主动脉根部直径比值0.29~0.65,平均 0.46 ± 0.21 。其中行VSD直接缝合24例,行补片植入14例。两组间一般情况比较无统计学差异($P>0.05$)(表1)。

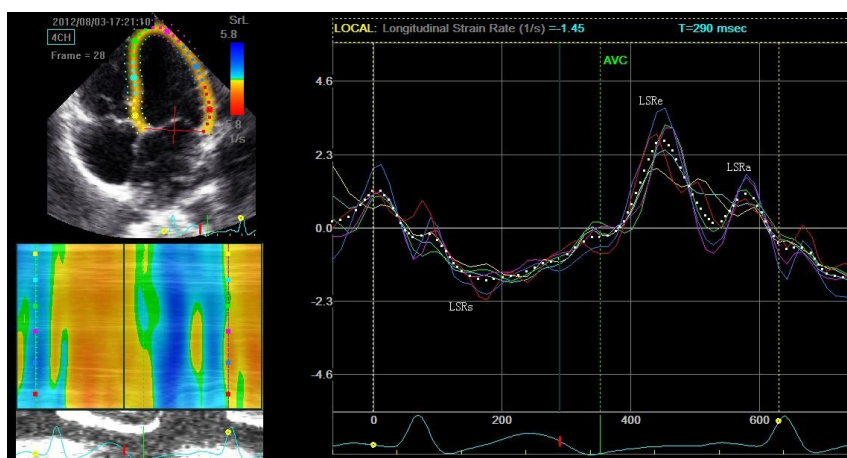


图2 左室纵向应变率图

Fig.2 LV longitudinal strain rate diagram

表1 对照组及室缺组一般情况比较($\bar{x} \pm s$)Tab.1 Data of VSD group and control group (Mean \pm SD)

Variable	Con group (n=30)	VSD group (n=38)
Age/years	6.6 \pm 3.3	6.3 \pm 2.9
Male/female	12/18	15/23
BSA/m ²	0.91 \pm 0.37	0.90 \pm 0.29
SBP/mmHg	101.38 \pm 9.65	106.32 \pm 10.92
DBP/mmHg	67.73 \pm 10.45	69.65 \pm 12.11
HR/bpm	90 \pm 16	92 \pm 19
mPAP/mmHg	18.78 \pm 5.43	19.94 \pm 5.78

BSA: Body surface area; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; mPAP: Mean pulmonary artery pressure

2.2 左室整体功能比较

VSD患者术前LVDD、LVDs、LVEDV、LVESV、LS及LSRs较对照组显著增大($P<0.05$ 或 $P<0.01$),但LVEF无差异($P>0.05$);E/e'显著增大($P<0.05$)、LSRe显著减小($P<0.05$),提示VSD患者虽然LVEF无明显变化但左心室心肌整体收缩功能增强而舒张功能减低。术后1周,LVEDV、LVESV、LVEF、LS及LSRs较对照组显著减小($P<0.05$ 或 $P<0.01$);E/e'及LSRe较对照组增大,提示VSD修补术后1周LVEF、左室心肌整体收缩及舒张功能均减低。VSD患者术后6个月,各指标与对照组比较无统计学差异($P>0.05$),说明LVEF、左室心肌整体收缩及舒张功能均恢复至正常水平(表2)。

2.3 室间隔局部功能比较

VSD患者术前,LS_{IVS}及LSR_{SIVS}显著增大($P<0.05$),LSRe_{IVS}显著减小($P<0.05$),提示VSD患者室间

隔局部的收缩功能增强而舒张功能减低。术后1周,LS_{IVS}、LSR_{SIVS}及LSRe_{IVS}较术前均显著减小($P<0.05$ 或 $P<0.01$),表明VSD修补术后1周室间隔局部的收缩、舒张功能均减低。术后6个月,LS_{IVS}、LSR_{SIVS}、LSRe_{IVS}较术后1周显著增大($P<0.05$),但低于对照组($P<0.05$),说明室间隔局部收缩、舒张功能虽然有所恢复但仍然低于正常水平(表3)。

2.4 重复性检验结果

2D-STI参数观察者内及观察者间差异分别为(4.7 \pm 2.6)%和(6.8 \pm 2.9)%。

3 讨论

VSD是临床常见的先天性心脏病,准确评价VSD修补术后左室功能对临床具有重要意义。室间隔是维护左室功能的重要结构,由两层斜行纤维构成,左心输出量的40%是由室间隔收缩完成^[6-7]。因而准确评价VSD修补术后室间隔局部功能,对临床评估左室整体功能具有重要临床价值。VSD修补术后围手术期室间隔局部功能受损在临床中已形成共识,但远期效果如何,目前尚不明确^[8-9]。2D-STI是近年发展起来的一项可早期、敏感评价心肌功能的新技术,已纳入2015年美国超声心动图学会指南,在评价左室功能方面优于LVEF,得到临床广泛应用^[10-11]。因而,本研究采用2D-STI中的纵向应变及应变率评价VSD修补术后左室整体及室间隔局部心肌功能。

本研究发现,VSD患者虽然LVEF无明显改变,但左室整体及间隔局部心肌的纵向收缩功能显著增加,而舒张功能减低。考虑由于VSD患者左室前负荷增加,心肌纤维拉长,根据Frank-Starling定律,收缩功能增强,以维持心脏正常的泵血功能^[12],这表明

表2 各组左室整体功能比较($\bar{x} \pm s$)Tab.2 Left ventricular function of each group (Mean \pm SD)

Variable	Con group (n=30)	Group1 (n=38)	Group2 (n=38)	Group3 (n=38)
LVDd/mm	33.99 \pm 4.83	38.69 \pm 5.54**	35.37 \pm 4.91 $^{\Delta}$	34.70 \pm 5.12 $^{\Delta\Delta}$
LVDs/mm	21.14 \pm 2.59	24.52 \pm 4.22*	22.29 \pm 5.14 $^{\Delta}$	21.93 \pm 4.46 $^{\Delta}$
LVEDV/mL	47.33 \pm 10.15	59.92 \pm 11.85**	52.27 \pm 6.89** $^{\Delta\Delta}$	46.69 \pm 8.45 $^{\Delta\Delta\Delta}$
LVESV/mL	18.27 \pm 5.10	22.86 \pm 11.26*	20.32 \pm 8.24* $^{\Delta}$	17.94 \pm 7.36 $^{\Delta\Delta}$
LVEF/%	59.28 \pm 6.32	61.77 \pm 7.39	57.12 \pm 6.87* $^{\Delta}$	60.38 \pm 5.71 $^{\Delta}$
E/A	1.58 \pm 0.16	1.61 \pm 0.39	1.57 \pm 0.23	1.60 \pm 0.25
E/e'	7.78 \pm 1.57	8.93 \pm 2.18*	8.86 \pm 1.92*	7.72 \pm 1.84 $^{\Delta\Delta}$
LS/%	-20.94 \pm 5.34	-23.62 \pm 4.73*	-14.38 \pm 4.19** $^{\Delta\Delta}$	-19.92 \pm 5.18 $^{\Delta\Delta\Delta}$
LSRs/s $^{-1}$	-1.56 \pm 0.41	-1.83 \pm 0.39*	-1.22 \pm 0.35* $^{\Delta\Delta}$	-1.62 \pm 0.29 $^{\Delta\Delta}$
LSRe/s $^{-1}$	1.43 \pm 0.24	1.21 \pm 0.41*	1.15 \pm 0.84*	1.36 \pm 0.52 $^{\Delta\Delta}$
LSRa/s $^{-1}$	1.22 \pm 0.37	1.26 \pm 0.65	1.32 \pm 0.78	1.29 \pm 0.62

Compared with control group, * $P < 0.05$, ** $P < 0.01$; compared with Group1, $^{\Delta}$ $P < 0.05$, $^{\Delta\Delta}$ $P < 0.01$; compared with Group2, $^{\Delta}$ $P < 0.05$, $^{\Delta\Delta}$ $P < 0.01$.

LVDd: Left ventricular end-diastolic dimension; LVDs: Left ventricular end-systolic dimension; LVEDV: Left ventricular end-diastolic volume; LVESV: Left ventricular end-systolic volume; LVEF: Left ventricular ejection fraction; E/e': Mitral early diastolic velocity/mitral annulus velocity; LS: Left ventricular systolic longitudinal strain; LSRs: Left ventricular systolic longitudinal strain rate; LSRe: Early diastolic strain rate; LSRa: Late diastolic strain rate

表3 各组室间隔局部功能比较($\bar{x} \pm s$)Tab.3 Interventricular septal regional function of each group (Mean \pm SD)

Variable	Con group (n=30)	Group1 (n=38)	Group2 (n=38)	Group3 (n=38)
LS _{ivs} /%	-21.04 \pm 3.22	-24.48 \pm 3.56*	-13.32 \pm 4.33** $^{\Delta\Delta}$	-17.74 \pm 5.46* $^{\Delta\Delta\Delta}$
LSR _{ivs} /s $^{-1}$	-1.40 \pm 0.34	-1.76 \pm 0.40*	-1.24 \pm 0.38* $^{\Delta\Delta}$	-1.21 \pm 0.51* $^{\Delta\Delta}$
LSRe _{ivs} /s $^{-1}$	2.24 \pm 0.66	1.67 \pm 0.89**	1.72 \pm 0.81**	1.93 \pm 0.68* $^{\Delta\Delta}$
LSRa _{ivs} /s $^{-1}$	1.09 \pm 0.47	1.17 \pm 0.46	1.15 \pm 0.75	1.18 \pm 0.82

Compared with control group, * $P < 0.05$, ** $P < 0.01$; compared with group1, $^{\Delta}$ $P < 0.05$, $^{\Delta\Delta}$ $P < 0.01$; compared with group2, $^{\Delta}$ $P < 0.05$.

在左室前负荷增加时,应变及应变率参数比 LVEF 指标能更敏感地反映左室局部心肌收缩功能的变化情况。同时本研究表明,VSD患者左室舒张功能减低,这亦是受前负荷影响,导致左室充盈压升高所致^[13]。

术后1周,LVEF、左室整体及室间隔局部心肌收缩、舒张功能均减低,首要原因是左室前负荷变化改变左室腔的压力,同时使左室几何形状发生变化,改变心肌纤维的曲度^[14]。其次,术中体外循环使心肌长久缺血及再灌注所致的心肌细胞损伤、手术本身造成的创伤等均严重影响心肌收缩及舒张功能。术后6个月时,左室整体心肌的收缩、舒张功能恢复至正常水平,但室间隔局部心肌收缩、舒张功能仍然减低,主要由于术中植入补片或缺损直接缝合使心肌

瘢痕形成、纤维化,导致局部心肌僵硬、弹性减小,影响室间隔的舒、缩功能^[15]。本研究室间隔局部功能并未影响左室整体功能,可能与本研究对象为中、小型VSD且排除肺高压,以及术后其他室壁功能代偿有关。

本研究仅探讨了室间隔膜周部中、小型缺损的患者,且样本量较小,拟在今后继续扩大样本量,探讨不同类型VSD修补术后左室各壁心肌的功能变化。

4 结论

VSD修补术后6个月,虽然左室整体心肌收缩、舒张功能恢复正常,但室间隔局部心肌收缩、舒张功能并未完全恢复,因而对VSD修补术后远期的患者

依然要定期检测, 观察室间隔局部功能, 及时为临床提供更为全面的信息, 同时2D-STI是准确评价室间隔局部功能的新方法。

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