

• 心脏介入 Cardiac intervention •

左右心室电极间距离指导心脏再同步化治疗
临床效果和安全性

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【摘要】 目的 探究左右心室电极间距离(DD)指导心脏再同步化治疗(CRT)的有效性和安全性。**方法** 选取 2018 年 5 月至 2020 年 1 月在南昌大学第一附属医院经最佳药物治疗并接受 DD 指导 CRT 的心力衰竭(心衰)患者 34 例作为观察组,既往研究中接受常规 CRT 心衰患者 75 例作为对照组。术后 CRT 影像资料获取:二维影像上用游标卡尺测量正位时心脏横径(L),分别在正位、左前斜位、右前斜位时测得 DD 并取最大值,计算 DD/L;记录左前斜 40°、右前斜 30°投影下左心室和右心室电极植入位置。参照《心血管系统疗效评价指标》和 meta 分析疗效评价标准,CRT 临床效果分为显效应答、有效应答和无应答。分析两组患者随访期因心衰再入院次数、全因病死例数。**结果** 观察组患者 CRT 应答总有效率略高于对照组(94.1% 对 89.3%, $P=0.721$),CRT 显效应答率显著高于对照组(29.4%对 9.3%, $P=0.007$)。观察组、对照组患者随访期因心衰再入院次数分别为 2 次、13 次,全因病死例数分别为 0 例、5 例。观察组 DD、DD/L 与对照组相比显著提高($P<0.001$)。观察组左心室电极位于基底部位比例高于对照组(70.0%对 18.0%, $P<0.05$),位于前外侧壁比例也高于对照组(46.7%对 19.7%, $P=0.007$)。右心室心尖部起搏右心室时,左心室电极位于前外侧壁和基底部可获得较高的 DD、DD/L;右心室室间隔中部起搏右心室时,左心室电极位于后外侧壁与较高的 DD 相关。**结论** DD 指导 CRT 安全性高,可提高 CRT 总体应答率。

【关键词】 左右心室电极间距离;心力衰竭;心脏再同步化治疗;安全性

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The clinical effect and safety of cardiac resynchronization therapy guided by the interlead distance between left and right ventricular electrodes DU Xingxiang, WENG Junfei, XIAO Qunlin, DONG Wei, HUANG Weilin, WANG Zhichao, LIU Qian, PENG Jingtian, ZHENG Zeqi, PENG Xiaoping. Department of Cardiology, First Affiliated Hospital of Nanchang University, Nanchang, Jiangxi Province 330006, China

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【Abstract】 Objective To investigate the clinical efficacy and safety of cardiac resynchronization therapy(CRT) guided by the interlead distance between left and right ventricular electrodes(DD). **Methods** A total of 34 patients with heart failure, who were admitted to the First Affiliated Hospital of Nanchang University of China to receive optimal medication together with DD-guided CRT, were enrolled in this study as study group, while other 75 patients with heart failure, who received routine CRT, which had already been reported in previous study, were used as control group. After treatment, CRT imaging materials were collected. On two-dimensional images the transverse diameter of heart(L) at anteroposterior(A-P) position, and the maximum DD values at A-P position, left anterior oblique(LAO) position and right anterior oblique(RAO) position were accurately measured by using vernier caliper, and the DD-to-L(DD/L) ratios were calculated. The projection sites of left and right ventricular electrodes at 40° LAO and 30° RAO positions were recorded. According to 《Evaluation Index of Curative Effect of Cardiovascular System》 and the evaluation criteria for curative efficacy based on meta analysis, the clinical effects of CRT were classified into significant response, effective response and no response. The number of readmission patient due to heart failure and the number of death

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due to all reasons during the follow-up period were compared between the two groups. **Results** In the study group, the total effective rate of response to CRT was 94.1%, which was slightly higher than 89.3% in the control group ($P=0.721$), and the significant response rate to CRT was 29.4%, which was strikingly higher than 9.3% in the control group ($P=0.007$). During the follow-up period, the numbers of readmission patient due to heart failure in the study group and in the control group were 2 and 3 respectively, and the numbers of death due to all reasons in the study group and in the control group were 0 and 5 respectively. The DD values and DD/L ratios in the study group were remarkably higher than those in the control group ($P<0.001$). The proportion of patients, in whom the left ventricular electrode was located at basal part of heart, in the study group was 70.0%, which was obviously higher than 18.0% in the control group ($P<0.05$); and the proportion of patients, in whom the left ventricular electrode was located at anterior lateral wall of heart, in the study group was 46.7%, which was significantly higher than 19.7% in the control group ($P=0.007$). Pacing right ventricle from right ventricular apex could obtain higher DD values and DD/L ratios when the left ventricular electrode was located at the anterior lateral wall or basal part of heart; and pacing right ventricle from the middle part of interventricular septum could obtain higher DD values, which were well correlated with the posterior lateral wall location of the left ventricular electrode. **Conclusion** The DD-guided CRT carries high safety, and this technique can improve the overall response rate to CRT. (J Intervent Radiol, 2021, 30: 331-335)

[Key words] distance between left and right ventricular electrodes; heart failure; cardiac resynchronization therapy; safety

心脏再同步治疗(cardiac resynchronization therapy, CRT)可改善射血分数降低和宽 QRS 波群患者心力衰竭(心衰)症状和心功能,降低死亡率^[1-2],但仍有 20%~40%患者未从中获益^[3-4]。随机对照试验研究显示影像(心脏 MR、超声下斑点示踪)引导下将左心室电极植于无瘢痕最晚机械运动心肌节段,可改善 CRT 反应^[5-7]。影像导引耗时、昂贵,使患者过多暴露于 X 线辐射中,且需非常规体位才能获得良好图像和较长手术时间,增加术后感染风险^[8],因此可能不适用于多数中心。以往研究主要关注左心室电极植入部位,对右心室电极植入部位关注较少。目前对适用于所有心衰患者最佳心室电极位置尚无定论^[4]。有研究提出,将左右心室电极间距离(DD)最大化可能与更好的临床疗效相关^[9-11]。为了简化操作流程,进一步观察 DD 对 CRT 疗效的影响,本研究在左心室电极固定后调整右心室电极植入部位,以获得最大间距指导 CRT,为改善心衰患者 CRT 总体应答率提供临床依据。

1 材料与方法

1.1 研究对象和分组

连续选择 2018 年 5 月至 2020 年 1 月在南昌大学第一附属医院经最佳药物治疗并接受 DD 指导下行 CRT 起搏器(CRT-P)/CRT 除颤器(CRT-D)植入治疗的心衰患者 34 例作为观察组,既往研究中接受常规 CRT 心衰患者 75 例^[11]作为对照组。患者纳入标准:①依据《2016 年欧洲心脏病学会(ESC)

急/慢性心力衰竭治疗指南》,慢性心衰经最佳药物治疗 3 个月后美国纽约心脏病协会(NYHA)心功能分级仍 \geq II 级,且 QRS 波宽 ≥ 120 ms,或左心室射血分数(LVEF) $< 35\%$;②签署 CRT 手术知情同意书。排除标准:①有心脏瓣膜置换史;②恶性肿瘤病史;③冠状动脉旁路移植手术史;④近 3 个月内发生严重心、脑血管事件;⑤严重肝、肾功能损害;⑥肺动脉收缩压(PASP) ≥ 50 mmHg(1 mmHg=0.133 kPa);⑦随访数据获取困难。

1.2 DD 指导下 CRT 植入术

局部麻醉下行左锁骨下静脉穿刺,引入导丝置鞘,皮下制作 CRT 囊袋并充分止血,置入冠状静脉导引系统,逆行 DSA 造影显示冠状静脉各分支情况;根据 Vardas 等^[12]分类描述左心室心肌节段,左前斜 40°投射下根据各分支情况,优先将冠状静脉前侧壁分支作为靶静脉,另在右前斜 30°投影下,将电极优先植于左心室基底部;调整心室电极参数(阈值、感知及阻抗),使无膈神经刺激,冠状静脉导引系统撤出,左心室电极位置稳定;根据左心室电极最终植入位置,多角度投影下将 DD 作为参考,取 DD 最大值作为最终右心室电极植入位置(心尖部或室间隔部),各参数理想后固定右心室电极;惯例植入右心房电极导线,各参数理想后连接起搏电极,起搏器正常工作并植入于皮下囊袋,分层缝合皮肤伤口。

1.3 观察指标和疗效评价

分析两组患者术前一般资料如年龄、性别、心

电图(ECG)、NYHA 分级、6 min 步行试验(6MWT)距离、心脏彩色超声、口服药物、基础疾病(高血压、糖尿病、心房颤动)及术后 CRT 影像资料,术后 6 个月门诊随访心脏彩色超声、ECG、NYHA 分级、6MWT 距离等资料,以及随访期间因心衰再入院次数、全因病死例数。

术后 CRT 影像资料获取:二维影像上用游标卡尺测量正位时心脏横径(L),分别在正位、左前斜位、右前斜位时测得 DD 并取最大值,计算 DD 与 L 比(DD/L)^[11];记录左前斜 40°、右前斜 30°投影下左心室和右心室电极植入位置^[12-13]。参照《心血管系统疗效评价指标》和 meta 分析疗效评价标准^[14],CRT 临床效果分为显效应答(术后 6 个月 Δ NYHA 分级 \geq +2 级或 Δ LVEF \geq +14.5%)、有效应答(NYHA 分级 \geq +1 级或 LVEF \geq +5%)和无应答(NYHA 分级 $<$ +1 级或 LVEF $<$ +5%)。总有效率=(显效例数+有效例数)/总例数 \times 100%。

1.4 统计学分析

采用 SPSS 23.0 软件分析数据。计量资料以均数 \pm 标准差($\bar{x}\pm s$)表示,组间均数差异比较用 t 检验;计数资料以频数或率表示,采用卡方检验, $P<0.05$ 为差异有统计学意义。

2 结果

两组患者基线资料,除观察组 DD、DD/L 水平较对照组明显升高外,差异均无统计学意义($P>0.05$),见表 1。观察组患者 CRT 应答总有效率略高于对照组(94.1% 对 89.3%, $P=0.721$),CRT 应答显效率显著高于对照组(29.4%对 9.3%, $P=0.007$)。观察组、对照组患者随访期因心衰再入院次数分别为 2 次、13 次,全因病死例数分别为 0 例、5 例。观察组未见手术相关并发症,见表 2。

两组患者术后投影下左右心室电极位置分布情况见表 3。观察组左心室电极在右前斜 30°投影下,植入基底部位比例明显高于对照组(70.0%对 18.0%, $P<0.05$),且在左前斜 40°投影下,植入前外侧壁部位比例明显高于对照组(46.7%对 19.7%, $P=0.007$)。

右心室心尖部起搏右心室时,前外侧壁(左前斜 40°)与外侧壁 DD/L 差异有统计学意义($P<0.05$),前外侧壁与后外侧壁 DD、DD/L 差异均有统计学意义($P<0.05$), F 检验显示 3 部分间 DD、DD/L 差异均有显著统计学意义($P=0.002$, $P<0.001$);基底部(右前斜 30°)与中部比较,DD、DD/L 差异均有显著统计

表 1 两者患者基线资料比较

| 参数 | 对照组 ($n=75$) | 观察组 ($n=34$) | $t/Z/\chi^2$ 值 | P 值 |
|------------------|--------------------|--------------------|----------------|----------|
| 男性/ n (%) | 38(50.7) | 17(50.0) | 0.004 | 0.949 |
| 年龄/岁 | 64.11 \pm 9.62 | 65.12 \pm 9.51 | -0.510 | 0.611 |
| NYHA 分级/ n (%) | | | 1.277 | 0.259 |
| Ⅲ级 | 64(85.3) | 26(76.5) | | |
| Ⅳ级 | 11(14.7) | 8(23.5) | | |
| 病因/ n (%) | | | | |
| 扩张型心肌病 | 44(58.7) | 24(70.6) | 1.417 | 0.234 |
| 缺血性心肌病 | 31(41.3) | 8(23.5) | 3.227 | 0.072 |
| 基础疾病/ n (%) | | | | |
| 高血压 | 45(60.0) | 14(41.2) | 3.338 | 0.068 |
| 糖尿病 | 25(33.3) | 9(31.2) | 0.513 | 0.474 |
| 心房颤动 | 10(13.3) | 6(17.6) | 0.348 | 0.568 |
| 口服药物/ n (%) | | | | >0.050 |
| ACEI/ARB | 68(90.7) | 29(76.5) | | |
| 利尿剂 | 75(100.0) | 34(100.0) | | |
| 醛固酮 | 72(96.0) | 33(97.1) | | |
| 地高辛 | 75(100.0) | 31(91.2) | | |
| LVEF/% | 31.01 \pm 3.39 | 30.12 \pm 3.05 | -1.873 | 0.061 |
| LVEDD/mm | 67.84 \pm 8.38 | 66.71 \pm 8.09 | -0.098 | 0.922 |
| LAAPD/mm | 43.89 \pm 6.64 | 41.09 \pm 5.40 | -1.864 | 0.062 |
| QRS 波宽/ms | 170.97 \pm 18.79 | 165.18 \pm 13.28 | 1.843 | 0.069 |
| 6MWT 距离/m | 201.16 \pm 42.82 | 205.21 \pm 37.89 | -0.473 | 0.637 |
| L/mm | 107.69 \pm 12.71 | 104.45 \pm 9.97 | 1.439 | 0.154 |
| DD/mm | 45.21 \pm 13.22 | 55.75 \pm 8.15 | -5.095 | <0.001 |
| DD/L/% | 0.42 \pm 0.12 | 0.54 \pm 0.08 | -5.853 | <0.001 |

ACEI: 血管紧张素转化酶抑制剂;ARB: 血管紧张素受体阻断剂;LVEDD: 左心室舒张末内径;LAAPD: 左心房前后径

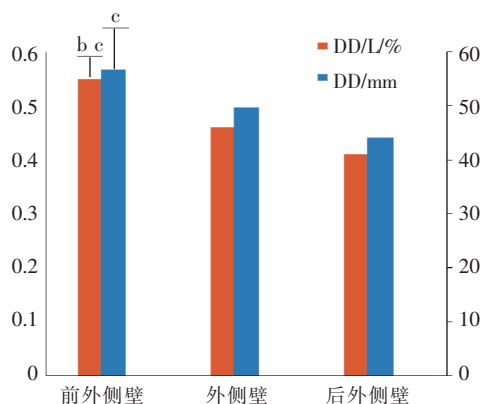
表 2 两组患者临床疗效比较 n (%)

| 组别 | 显效应答 | 有效应答 | 无应答 | 总有效 |
|---------------|----------|----------|---------|----------|
| 对照组($n=75$) | 7(9.3) | 60(80.0) | 8(10.7) | 67(89.3) |
| 观察组($n=34$) | 10(29.4) | 22(64.7) | 2(5.9) | 32(94.1) |
| χ^2 值 | 7.165 | 2.937 | 0.643 | 0.643 |
| P 值 | 0.007 | 0.087 | 0.721 | 0.721 |

表 3 两组患者左右心室电极位置 n (对照组/观察组)

| 右心室电极 | 右前斜 30° | | | 左前斜 40° | | | | |
|-------|---------|------|-------|---------|-------|------|------|-----|
| | 心尖部 | 中部 | 基底部 | 前侧 | 前外侧 | 外侧 | 后外侧 | 后侧 |
| 心尖部 | 17/3 | 33/6 | 11/21 | 9/9 | 12/14 | 22/7 | 14/0 | 4/0 |
| 中位间隔 | 4/1 | 6/1 | 0/2 | 0/0 | 1/0 | 2/0 | 5/3 | 2/1 |
| 高位间隔 | 2/0 | 2/0 | 0/0 | 0/0 | 1/0 | 2/0 | 1/0 | 0/0 |

学意义[(59.59 \pm 8.40) mm 对(47.69 \pm 10.25) mm, $P<0.001$;(0.56 \pm 0.08)%对(0.46 \pm 0.10)%, $P<0.001$];中部与心尖部比较,DD、DD/L 差异均有显著统计学意义[(47.69 \pm 10.25) mm 对(35.16 \pm 9.32) mm, $P<0.001$;(0.46 \pm 0.10)%对(0.32 \pm 0.08)%, $P<0.001$],见图 1。右心室室间隔中部起搏右心室时,后外侧壁(左前斜 40°)与外侧壁 DD、DD/L 差异均无统计学意义($P=0.953$, $P=0.962$);后外侧壁与后侧壁比较,DD 差异有统计学意义[(51.29 \pm 7.90) mm 对(35.76 \pm 10.79) mm, $P=0.046$]。



^b 与外侧壁比较, $P < 0.05$; ^c 与后外侧壁比较, $P < 0.05$

图 1 69 例右心室电极位于心尖部患者左心室电极在左前斜 40° 时不同位置测得的 DD、DD/L

3 讨论

近年药物治疗心衰效果取得了长足提高, 但仍有 12.8% 患者因心衰住院治疗^[15-16]。对于这些患者, 行 CRT 大多有益。本研究结果表明, 观察组更高的 CRT 应答率与更高的 DD、DD/L 水平明显相关, 且 DD 越大, CRT 效果越佳。

过去认为 LV 导联最常置于冠状静脉窦的基底、外侧或后外侧侧支^[4]。于海波等^[17]研究报道, 相对于植入前侧壁, 左心室侧壁或后侧壁植入左心室电极临床效果更佳。Algazzar 等^[18]研究认为冠状静脉窦后外侧支是最好的植入部位选择。一些研究表明非心尖 RV 导联位置起搏, 可获得更好的血流动力学效果^[18-20], 在左心室逆向重构方面没有差别^[18, 21-22]。有关 RV 导联位置的临床结果数据也相互矛盾, 尤其是缺乏远期随访数据^[23-26]。可见, CRT 左右心室电极植入最佳位置存在较大争议。这可能是由于这些研究仅考虑单一电极不同植入位置。目前尚无研究数据可检验特定的 RV 和 LV 导联位置组合是否会影响临床结果。右心室心尖部起搏右心室、LV 电极植入侧壁-基底部或前外侧-基底部时产生的 DD 更大, 右心室室间隔部位起搏右心室、LV 电极植入后外侧时获得的左右心室 DD 可能更大^[9-10]。本研究结果显示, 右心室心尖部起搏右心室时前外侧-基底部位置应是左心室电极植入首选位置, 前外侧-中部可为次要选择; 右心室电极位于中位间隔时, 后外侧-基底部可获得更大的 DD。Algazzar 等^[18]研究还显示, LV 电极位于外侧壁时, RV 电极位于心尖部或中位间隔, 起搏效应差异并无统计学意义。Heist 等^[27]研究发现, 接受常规 CRT 治疗患者侧位 X 线片上测得的 DD 较长, 而不是在前后位, 这与患者血流动力学急性改善有关。

本研究以最大化 DD 水平指导 CRT 手术植入, 植入过程中可获得最大 DD, 同样也可取得最大 DD/L。Clementy 等^[9]研究显示, 预测 CRT 应答的 DD/L 最佳临界值为 ≥ 0.53 (灵敏度 83%, 特异度 75%, 曲线下面积 0.84, $P = 0.0002$), 患者因心衰住院风险降低 70% ($P = 0.004$); 认为 DD 是预测 6 个月后 CRT 疗效的最佳独立指标。一些前瞻性研究聚焦于左心室电极植于心肌无瘢痕的最晚机械收缩部位, 但仍有部分患者对双心室起搏的 CRT 无应答或应答率低^[5-7], 这可能与患者获得的 DD 和 DD/L 较小相关。

本研究观察组患者术后随访期间未出现手术相关并发症, 再入院率和全因病死率均显著低于对照组。可见在左心室电极固定后调整右心室电极植入部位, 以获得最大间距导引 CRT, 是一种操作相对简单、安全性较高、可重复的方法, 有助于在基层医疗中心应用。针对因各种原因常规心室起搏患者对 CRT 无应答, 可考虑单独行左心室起搏。此外, 更多起搏配置如四极电极, 已在临床实践中应用^[28]。CRT 实际手术过程中, LV 电极定位通常需考虑冠状静脉解剖情况如管腔是否闭塞, 是否引起膈肌刺激等, 且在定位 RV 电极时要确保除颤功能不会受到影响。本研究主要局限在于观察组样本量及右心室电极位于室间隔中部病例相对较少, 未及评估右心室电极位于高位间隔对 CRT 应答的影响。

总之, 本研究结果显示 DD 指导 CRT 安全性高, 可提高 CRT 总体应答率。未来结合影像学 and 3D 打印技术有助于进一步提高 CRT 总体应答率, 有待进一步深入研究。

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