



## • 诊治分析 •

(扫描二维码查看原文)

# 心脏手术患者体外循环心脏复跳后心电图Ⅱ导联QRS波演变情况及其临床意义

张军，赵雪屏，高文燕

**【摘要】** 背景 体外循环(CPB)是替代心脏手术患者术中心肺功能的重要方式，准确预测CPB心脏复跳患者心功能恢复情况至关重要。心脏复跳后心电图QRS波演变或与心肌细胞功能恢复有一定关系，目前国内外尚无研究具体分析QRS波演变情况对心肌功能的预测价值。**目的** 探讨心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波演变情况及其临床意义。**方法** 选取2019年1月至2020年8月山西省心血管病医院心脏外科收治的CPB心脏手术患者180例，其中瓣膜置换术108例，瓣膜成形术47例，冠状动脉旁路移植术(CABG)15例，瓣膜置换术联合CABG10例。观察患者CPB心脏复跳后心电图Ⅱ导联QRS波演变情况，记录术中主动脉阻断时间。比较不同手术方式患者CPB心脏复跳后15、30、>30 min心电图Ⅱ导联QRS波演变发生率；比较CPB心脏复跳心电图Ⅱ导联QRS波发生演变与未发生演变患者的术中主动脉阻断时间；比较QRS波时限<110 ms与QRS波时限≥110 ms患者心功能指标〔纽约心脏病协会(NYHA)分级、左心室射血分数(LVEF)、血清N末端脑钠肽前体(NT-proBNP)水平〕。采用Spearman秩相关分析探讨心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波时限与心功能指标的相关性。**结果** 术前，心脏手术患者心电图Ⅱ导联QRS波表现为主波向下，呈rS型。143例(79.44%)患者自CPB心脏复跳即刻自主心律和呼吸频率逐渐恢复正常，QRS波呈Rs型伴增宽；CPB心脏复跳后15 min，QRS波呈rS型伴S波增宽；CPB心脏复跳后30 min，QRS波呈Rs型，时程恢复正常；CPB心脏复跳后35 min，QRS波呈Rs型，时程缩短，而后逐渐恢复至术前形态。不同手术方式患者CPB心脏复跳后15、30、>30 min心电图Ⅱ导联QRS波演变发生率比较，差异无统计学意义( $P > 0.05$ )。143例CPB心脏复跳后心电图Ⅱ导联QRS波发生演变者的主动脉阻断时间短于37例CPB心脏复跳后心电图Ⅱ导联QRS波未发生演变者( $P < 0.001$ )。180例患者中，QRS波时限<110 ms者88例，QRS波时限≥110 ms者92例。QRS波时限<110 ms患者NYHA分级优于QRS波时限≥110 ms患者，LVEF高于QRS波时限≥110 ms患者，血清NT-proBNP水平低于QRS波时限≥110 ms患者( $P < 0.05$ )。Spearman秩相关分析结果显示，心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波时限与LVEF呈负相关( $r_s=-0.654$ ,  $P < 0.001$ )，与NYHA分级、血清NT-proBNP水平呈正相关( $r_s$ 值分别为0.634、0.627,  $P$ 值均<0.001)。**结论** 心脏手术患者CPB心脏复跳后自主心律和呼吸逐渐恢复正常，心电图Ⅱ导联QRS波逐渐演变为主波向下，呈Rs型，时程缩短，直至恢复至术前形态，术中主动脉阻断时间可能会影响患者CPB心脏复跳后心电图Ⅱ导联QRS演变情况，而QRS波时限越长，心功能损伤越严重，故推测心电图Ⅱ导联QRS波或可作为临床评估心功能的重要指标。

**【关键词】** 心脏外科手术；体外循环；心脏复跳；心电图；QRS波；心肌功能

**【中图分类号】** R 654.2 **【文献标识码】** A **DOI:** 10.12114/j.issn.1008-5971.2021.00.279

张军，赵雪屏，高文燕.心脏手术患者体外循环心脏复跳后心电图Ⅱ导联QRS波演变情况及其临床意义[J].实用心脑肺血管病杂志，2021，29(12)：107-111. [www.syxnf.net]

ZHANG J, ZHAO X P, GAO W Y. Evolution and clinical significance of QRS wave of ECG lead Ⅱ after cardiac rebeating in cardiopulmonary bypass of patients undergoing cardiac surgery [J]. Practical Journal of Cardiac Cerebral Pneumal and Vascular Disease, 2021, 29 (12) : 107-111.

**Evolution and Clinical Significance of QRS Wave of ECG Lead Ⅱ after Cardiac Rebeating in Cardiopulmonary Bypass of Patients Undergoing Cardiac Surgery** ZHANG Jun, ZHAO Xueping, GAO Wenyan

Department of Cardiopulmonary Bypass, Shanxi Cardiovascular Hospital, Taiyuan 030024, China

Corresponding author: ZHANG Jun, E-mail: 13834236808@163.com

**【Abstract】** **Background** Cardiopulmonary bypass (CPB) is an important way to replace the pulmonary function of patients undergoing cardiac surgery, and it is very important to accurately predict the recovery of cardiac function of patients with cardiac rebeating in CPB. The evolution of QRS wave in ECG after cardiac rebeating may be related to the recovery of myocardial

cell function. At present, there is no study to specifically analyze the predictive value of QRS wave evolutionon for myocardial functionat at home and abroad. **Objective** To discuss the evolution and clinical significance of QRS wave of ECG lead II after cardiac rebeating in CPB of patients undergoing cardiac surgery. **Methods** A total of 180 patients who underwent cardiac surgery under CPB in Cardiac Surgery Department, Shanxi Cardiovascular Hospital from January 2019 to August 2020 were selected, among them, there were 108 cases of valve replacement, 47 cases of valvuloplasty, 15 cases of coronary artery bypass grafting (CABG) and 10 cases of valve replacement combined with CABG. The evolution of QRS wave in lead II of ECG after cardiac rebeating in CPB was observed, and the intraoperative aortic occlusion time was recorded. Incidence of QRS wave evolution in lead II of ECG at 15, 30 and > 30 min after cardiac rebeating in CPB were compared in patients with different operation methods; intraoperative aortic occlusion time was compared between the patients with QRS wave evolution or not in ECG lead II of ECG after cardiac rebeating in CPB; and the cardiac function indexes [New York Heart Association (NYHA) grade, left ventricular ejection fraction (LVEF), serum N-terminal pro-brain natriuretic peptide (NT-proBNP) level] were compared between patients with QRS wave duration < 110 ms and patients with QRS wave duration ≥ 110 ms. Spearman rank correlation analysis was used to explore the correlation between QRS wave duration in lead II of ECG and cardiac function indexes after cardiac rebeating in CPB of patients undergoing cardiac surgery. **Results** Before operation, the QRS wave in lead II of ECG of patients undergoing cardiac surgery showed the main wave downward, showing rS type; spontaneous heart rhythm and respiratory rate of 143 patients (79.44%) gradually returned to normal immediately after cardiac rebeating in CPB, and the QRS wave showed Rs type with widening; 15 min after cardiac rebeating in CPB, QRS wave showed rS type with S wave widening; 30 min after cardiac rebeating in CPB, QRS wave showed Rs type and the time course returned to normal; 35 min after cardiac rebeating in CPB, the QRS wave showed Rs type, the time course was shortened, and then gradually returned to the preoperative shape. There was no significant difference in incidence of QRS wave evolution in lead II of ECG at 15, 30 and > 30 min after cardiac rebeating in CPB in patients with different operation methods ( $P > 0.05$ ). Intraoperative aortic occlusion time of 143 patients with QRS wave evolution in lead II of ECG after cardiac rebeating in CPB was shorter than that of 37 patients without QRS wave evolution ( $P < 0.001$ ). Of 180 cases of patients, 88 cases with QRS wave duration < 110 ms, 92 cases with QRS wave duration ≥ 110 ms. NYHA grade in patients with QRS wave duration < 110 ms was better than that of patients with QRS wave duration ≥ 110 ms, LVEF was higher than that of patients with QRS wave duration ≥ 110 ms, serum NT-proBNP level was lower than that of patients with QRS wave duration ≥ 110 ms ( $P < 0.05$ ). Spearman rank correlation analysis showed that, QRS wave duration in lead II of ECG was negatively correlated with LVEF ( $r_s = -0.654$ ,  $P < 0.001$ ), and was positively correlated with NYHA grade and serum NT-proBNP level of patients after cardiac rebeating in CPB undergoing cardiac surgery ( $r_s$  value was 0.634, 0.627, respectively; P values were both < 0.001). **Conclusion** The spontaneous rhythm and breathing after cardiac rebeating in CPB of patients undergoing cardiac surgery gradually recover, and the QRS wave in lead II of ECG gradually evolves into the main wave downward, showing Rs type, and the time course is shortened until it returns to the preoperative shape. Intraoperative aortic occlusion time may affect the QRS evolution in lead II of ECG after cardiac rebeating in CPB of patients. The longer the QRS wave duration, the more serious the damage of cardiac function. Therefore, it is speculated that QRS wave in lead II of ECG may be an important index for clinical evaluation of cardiac function.

**[Key words]** Cardiac surgical procedures; Extracorporeal circulation; Cardiac rebeating; Electrocardiogram; QRS wave; Myocardial function

全球每年有超百万患者接受心脏手术，体外循环（cardiopulmonary bypass, CPB）是替代心脏手术患者术中心肺功能的重要方式。心脏手术需在心脏停跳的情况下进行，极易因心肌缺血和再灌注损伤而导致心肌细胞功能恢复缓慢<sup>[1]</sup>，但如何准确地评价CPB心脏复跳患者心肌功能恢复情况尚缺乏客观的参考指标。QRS波是心室除极的整体波，代表室间隔、左心室和右心室的除极电位，心电图表现为高而尖的偏折波群<sup>[2-3]</sup>，第1个负向偏折波被称为Q波，第1个正向偏折波被称为R波，正向偏折波后的负向偏折波称为S波，合称为QRS波<sup>[4]</sup>。临床研究表明，CPB心脏复跳患者心电图QRS波变化或与心肌细胞功能恢复有一定关系<sup>[5]</sup>。但目前国内外尚无研究具体分析QRS波对心肌功能的预测价值。基于此，本研究旨在探讨心脏手术患者CPB心脏复跳后心电图II导联

QRS波演变情况及其临床意义，现报道如下。

## 1 资料与方法

**1.1 一般资料** 选取2019年1月至2020年8月在山西省心血管病医院心脏外科行CPB心脏手术的患者180例。纳入标准：（1）年龄18~75岁；（2）窦性心律；（3）接受CPB心脏手术，且术后接受心电监测；（4）自愿参与本研究，并签署知情同意书。排除标准：（1）术前存在房室传导阻滞、束支传导阻滞、旁路传导或起搏心律者；（2）心房颤动者；（3）严重肝肾功能衰竭或严重感染者；（4）临床资料不完整者。所有患者中，男96例，女84例；年龄24~74岁，平均（56.4±12.4）岁；合并症：高血压68例，糖尿病52例，高脂血症46例；手术方式：瓣膜置换术108例，瓣膜成形术47例，冠状动脉旁路移植术（coronary artery bypass grafting，

CABG) 15例,瓣膜置换术联合CABG 10例。本研究经山西省心血管病医院伦理委员会审核批准,患者对本研究知情并签署知情同意书。

**1.2 方法** 患者麻醉前30 min肌肉注射东莨菪碱0.05 mg/kg、吗啡0.1 mg/kg;患者进入手术室后,予以面罩吸氧,应用多功能监护仪动态监测其脉搏血氧饱和度和无创血压,并静脉注射地西泮0.10 mg/kg、依托咪酯0.15 mg/kg、芬太尼20 μg/kg和哌库溴铵0.1 mg/kg行麻醉诱导,而后予以气管插管行机械通气,设置潮气量为8~10 ml,呼吸频率为12~15次/min,动脉血二氧化碳分压为4.6~6.0 kPa;术中,静脉泵注芬太尼70~100 μg/kg、异丙酚100 μg/kg以维持麻醉。

应用德国 Stockert III型人工心肺机、德国 Stockert III型变温器配合TERUMO(商品名:集成式膜式氧合器)进行中低温(28~32 °C)非搏动CPB灌注,患者平均动脉压为50~80 mm Hg(1 mm Hg=0.133 kPa),故设置灌注压力为180~220 mm Hg,在此期间采用冷血液停跳液进行心肌灌注,使心脏在停跳期间也能进行有氧代谢,以减轻心肌缺血及再灌注损伤。

### 1.3 观察指标

**1.3.1 心电图Ⅱ导联QRS波形态、主波方向演变** 应用GE多功能监护仪监测患者心电情况,以心脏恢复节律规整的自主心律为起点,连续观察患者CPB心脏复跳后心电图Ⅱ导联QRS波变化情况,包括QRS波形态、主波方向演变情况。比较不同手术方式患者CPB心脏复跳后15、30、>30 min QRS波演变发生率,记录患者术中主动脉阻断时间。将QRS波由异常形态向正常形态变化视为QRS波发生演变,时间段的选择参照文献[6]。

**1.3.2 心功能指标** 比较QRS波时限<110 ms与QRS波时限≥110 ms患者心功能指标,包括纽约心脏病协会(New York Heart Association, NYHA)分级[I级:无明显心力衰竭或心功能不全的临床表现及症状;II级:出现左心衰竭症状,肺部啰音范围<50%肺野,静脉压升高;III级:出现明显心力衰竭或心功能不全症状及体征,肺部啰音范围≥50%肺野;IV级:并发低血压或心源性休克,并伴有不同程度血流动力学改变]、左心室射血分数(left ventricular ejection fraction, LVEF)、血清N末端脑钠肽前体(N-terminal pro-brain natriuretic peptide, NT-proBNP)水平,其中LVEF是应用Philips-IU22彩色多普勒超声诊断仪测得。抽取患者空腹肘静脉血5 ml,3 500 r/min离心10 min(离心半径为13.5 cm),取上清液;采用酶联免疫吸附试验检测血清NT-proBNP水平。QRS波时限指QRS波起点到终点的时程,参考范围为60~100 ms,最多不超过110 ms<sup>[7]</sup>。

**1.4 统计学方法** 应用SPSS 20.0统计学软件进行数据处理。计数资料以相对数表示,组间比较采用χ<sup>2</sup>检验,等级资料比较采用秩和检验;计量资料以( $\bar{x} \pm s$ )表示,组间比较采用两独立样本t检验;采用Spearman秩相关分析探讨心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波时限与心功能指标的相关性。以P<0.05为差异有统计学意义。

## 2 结果

**2.1 心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波形态、主波方向演变情况** 术前,心脏手术患者心电图Ⅱ导联QRS波表现为主波向下,呈rS型。143例(79.44%)患者自CPB心脏复跳即刻自主心律和呼吸频率逐渐恢复正常,QRS波呈Rs型伴增宽;CPB心脏复跳后15 min,QRS波呈rS型伴S波增宽;CPB心脏复跳后30 min,QRS波呈Rs型,时程恢复正常;CPB心脏复跳后35 min,QRS波呈Rs型,时程缩短,而后逐渐恢复至术前形态。不同手术方式患者CPB心脏复跳后15、30、>30 min心电图Ⅱ导联QRS波演变发生率比较,差异无统计学意义(P>0.05),见表1。

**表1 不同手术方式患者CPB心脏复跳后不同时间点心电图Ⅱ导联QRS波演变发生率比较[n(%)]**

**Table 1 Comparison of QRS evolution rate of ECG lead II at different time points after cardiac rebeating in CPB in patients with different operation methods**

手术方式	例数	CPB心脏复跳后15 min	CPB心脏复跳后30 min	CPB心脏复跳后>30 min
瓣膜置换术	108	27(25.00)	41(37.96)	20(18.52)
瓣膜成形术	47	10(21.28)	17(36.17)	9(19.15)
CABG	15	4/15	6/15	2/15
瓣膜置换术联合CABG	10	3/10	3/10	1/10
χ <sup>2</sup> 值		0.481	0.320	0.718
P值		0.923	0.956	0.869

注:CPB=体外循环,CABG=冠状动脉旁路移植术

**2.2 心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波演变情况与术中主动脉阻断时间的关系** 所有患者中,143例CPB心脏复跳后心电图Ⅱ导联QRS波发生演变者的主动脉阻断时间为(24.55±2.48)min,短于37例CPB心脏复跳后心电图Ⅱ导联QRS波未发生演变者的(105.28±12.45)min,差异有统计学意义(t=72.691,P<0.001)。

**2.3 心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波时限与心功能指标的关系** 180例患者中,QRS波时限<110 ms者88例,QR时限≥110 ms者92例。QRS波时限<110 ms患者NYHA分级优于QRS波时限≥110 ms患者,LVEF高于QRS波时限≥110 ms患者,血清NT-proBNP水平低于QRS波时限≥110 ms患者,差异有统计学意义(P<0.05),见表2。Spearman秩相关分析结果显示,心脏手术患者CPB心脏复跳后心电图Ⅱ导联QRS波时限与LVEF呈负相关(r<sub>s</sub>=-0.654,P<0.001),与NYHA分级、血清NT-proBNP水平呈正相关(r<sub>s</sub>值分别为0.634、0.627,P值均<0.001)。

## 3 讨论

心脏的重要功能是泵血,心脏规律的机械过程有赖于心肌细胞规律的电位变化。心电图检查是通过在人体不同部位放置电极,通过导联线与心电图机电流计的正负极相连,记录心脏每个心动周期所产生的电活动变化图形<sup>[8~9]</sup>。心电图作为临床评估患者心脏电生理活动的常用检查手段,多用于心律失常、心肌缺血患者的无创性检查,可提高临床诊断正

**表2** 心脏手术患者CPB心脏复跳后心电图II导联QRS波时限<110 ms与QRS波时限≥110 ms者心功能指标比较

**Table 2** Comparison of cardiac function indexes between cardiac surgery patients with QRS duration < 110 ms and those with QRS duration ≥ 110 ms of ECG lead II after cardiac rebeating in CPB

QRS波时限	例数	NYHA分级 [n (%) ]			LVEF ( $\bar{x} \pm s$ , %)	NT-proBNP ( $\bar{x} \pm s$ , ng/L)
		Ⅱ级	Ⅲ级	Ⅳ级		
< 110 ms	88	44 (50.0)	24 (27.3)	20 (22.7)	38.2 ± 5.5	1388.8 ± 354.6
≥ 110 ms	92	26 (28.3)	26 (28.3)	40 (43.5)	34.2 ± 4.5	2029.0 ± 520.4
$t$ 值		3.350			5.417 <sup>a</sup>	9.602 <sup>a</sup>
P值		0.001			< 0.001	< 0.001

注: <sup>a</sup> 表示  $t$  值; NYHA= 纽约心脏病协会, LVEF= 左心室射血分数, NT-proBNP=N 末端脑钠肽前体

确率; 此外, 心电图还常用于辅助导管消融技术治疗心律失常<sup>[10-12]</sup>, 但目前鲜有研究探讨心电图与心肌功能的关系。

刘红军等<sup>[13]</sup>认为, 心电图作为简易的无创性检查工具, 其显示的QRS波电压静态特征及动态演变特征可反映部分心脏解剖结构特征, 不仅可用于诊断心肌电活动, 同时对心肌、心包基础疾病及其他系统疾病的诊断和治疗具有辅助作用。本研究结果显示, 143例(79.44%)患者自CPB心脏复跳即刻自主心律和呼吸频率逐渐恢复正常, QRS波呈Rs型伴增宽; CPB心脏复跳后15 min, QRS波呈rs型伴S波增宽; CPB心脏复跳后30 min, QRS波呈Rs型, 时程恢复正常; CPB心脏复跳后35 min, QRS波呈Rs型, 时程缩短, 而后逐渐恢复正常至术前形态; 提示患者心电活动改变或与心肌缺血再灌注有关, 且CPB心脏复跳可有效改善心脏手术患者心肌细胞功能。此外, 不同手术方式患者CPB心脏复跳后15、30、>30 min心电图II导联QRS波演变发生率比较差异无统计学意义, 表明心脏手术患者CPB心脏复跳后不同时间点QRS波演变与手术方式无关。QRS波主波方向改变, 提示心肌除极起始向量发生改变, 可引起额面电轴改变, 出现异位起搏心率, 且起搏位点多位于房室束分叉以下和束支传导阻滞。相关研究表明, QRS波增宽与异位起搏、心肌缺血后心肌细胞膜去极化有关<sup>[14-15]</sup>。本研究心脏手术患者在CPB心脏复跳后心电图II导联QRS波逐渐演变为术前形态, 分析原因可能与异位起搏点逐渐向房室束分叉位移有关。本研究结果还显示, CPB心脏复跳后心电图II导联QRS波发生演变者的主动脉阻断时间短于CPB心脏复跳后心电图II导联QRS波未发生演变者, 提示心脏手术患者CPB心脏复跳后心电图II导联QRS波演变情况与术中主动脉阻断时间可能有关。

QRS波演变是心室肌细胞除极的过程, 当QRS波时限延长或形态发生异常时, 则提示患者心肌电生理紊乱, 可能存在心肌缺血或心功能损伤。近年有研究表明, QRS波形态与心肌缺血导致的心力衰竭患者心功能间有一定关系, 即心功能越差, QRS波形态异常发生率越高, QRS波时限越长<sup>[16]</sup>。本研究结果表明, QRS波时限<110 ms患者NYHA分级优于QRS波时限≥110 ms患者, LVEF高于QRS波时限≥110 ms患者, 血清NT-proBNP水平低于QRS波时限≥110 ms患者, 进一步进行Spearman秩相关分析, 结果显示, 心脏手术患者

CPB心脏复跳后心电图II导联QRS波时限与LVEF呈负相关, 与NYHA分级、血清NT-proBNP水平呈正相关, 表明心脏手术患者CPB心脏复跳后心电图II导联QRS波时限越长, 心功能损伤越严重, 提示心电图II导联QRS波时限可作为临床评估心脏手术患者CPB心脏复跳后心功能的客观指标, 以指导预后评估。

综上所述, 心脏手术患者CPB心脏复跳后自主心律和呼吸逐渐恢复, 心电图II导联QRS波逐渐演变为主波向下, 呈Rs型, 时程缩短, 直至恢复至术前形态, 术中主动脉阻断时间可能会影响患者CPB心脏复跳后心电图II导联QRS波演变情况, 而QRS波时限越长, 心功能损伤越严重, 故推测心电图II导联QRS波或可作为临床评估心功能的重要指标。但本研究仅初步探讨了CPB心脏复跳后心电图II导联QRS波演变情况, 并未深入分析心电图其他导联QRS波形态与患者心跳节律的关系; 此外, 本研究纳入样本量较小, 且均为窦性心律人群, 今后还需扩大样本量进一步深入研究以证实本结论。

作者贡献: 张军、赵雪屏进行文章的构思与设计; 张军进行研究的实施与可行性分析, 撰写、修订论文, 负责文章的质量控制及审校, 并对文章整体负责、监督管理; 高文燕进行数据收集、整理、分析; 张军、赵雪屏、高文燕进行结果分析与解释。

本文无利益冲突。

## 参考文献

- VARRICA A, SATRIANO A, GAVILANES A D W, et al. S100B increases in cyanotic versus noncyanotic infants undergoing heart surgery and cardiopulmonary bypass (CPB) [J]. J Matern Fetal Neonatal Med, 2019, 32 (7): 1117-1123. DOI: 10.1080/14767058.2017.1401604.
- LEE J S, LEE S J, CHOI M, et al. QRS detection method based on fully convolutional networks for capacitive electrocardiogram [J]. Expert Syst Appl, 2019, 134: 66-78. DOI: 10.1016/j.eswa.2019.05.033.
- REIJN N, LAZARO J, HOSSAIN M B, et al. Using the redundant convolutional encoder-decoder to denoise QRS complexes in ECG signals recorded with an armband wearable device [J]. Sensors, 2020, 20 (16): 4611. DOI: 10.3390/s20164611.
- LEDEZMA C A, ALTUVE M. Optimal data fusion for the improvement of QRS complex detection in multi-channel ECG recordings [J]. Med Biol Eng Comput, 2019, 57 (8): 1673-1681. DOI: 10.1007/s11517-019-01990-3.
- 何涛, 罗园柳. 心电图QRS波群对心脏再同步治疗效果判断的意义 [J]. 广西医科大学学报, 2015, 32 (3): 511-513.
- 刘金东, 颜铭, 丁伟, 等. 体外循环心脏复跳后心电图II导联QRS波群主波方向演变的临床观察 [J]. 江苏临床医学杂志, 2002, 6 (5): 420-422. DOI: 10.3969/j.issn.1672-2353.2002.05.012.
- LIU J D, YAN M, DING W, et al. The clinical observation on main-wave direction changes of patterns in electrocardiographic curve leads [J]. Journal of Jiangsu Clinical Medicine, 2002, 6 (5): 420-422. DOI: 10.3969/j.issn.1672-2353.2002.05.012.

- [7] 王立群.QRS 波时限鉴别宽 QRS 波心动过速 [J]. 临床心电学杂志, 2012, 21 (3): 164–165.DOI: 10.3969/j.issn.1005-0272.2012.03.003.
- [8] 沈亚萍, 殷张东. 24 h 动态心电图对起搏器植入患者心血管事件发生率诊断价值分析 [J]. 中国药物与临床, 2019, 19 (11): 146–147.DOI: 10.11655/zgywylc2019.11.074.
- [9] 李连海, 褚怀德, 刘建伟, 等. 12 导联动态心电图与常规心电图对老年冠心病病人无症状心肌缺血和心律失常的诊断价值 [J]. 中西医结合心脑血管病杂志, 2019, 17 (5): 787–789.DOI: 10.12102/j.issn.1672-1349.2019.05.041.
- [10] DASAGRANDHI D, KAMALABAI R A S, MUTHUSWAMY A, et al. Ischemia/reperfusion injury in male Guinea pigs: an efficient model to investigate myocardial damage in cardiovascular complications [J]. Biomed Pharmacother, 2018, 99: 469–479. DOI: 10.1016/j.biopha.2018.01.087.
- [11] BIGLER M R, STOLLER M, PRAZ F, et al. Functional assessment of myocardial ischaemia by intracoronary ECG [J]. Open Heart, 2021, 8 (1): e001447.DOI: 10.1136/openhrt-2020-001447.
- [12] LOBEEK M, BADINGS E, LENSSEN M, et al. Diagnostic value of the electrocardiogram in the assessment of prior myocardial infarction [J]. Neth Heart J, 2021, 29 (3): 142–150.DOI: 10.1007/s12471-020-01515-w.
- [13] 刘红军, 卢建平, 卢国群, 等. 心电图 QRS 波群电压的临床意义 [J]. 实用心电学杂志, 2016, 25 (1): 52–54.DOI: 10.13308/j.issn.2095-9354.2016.01.013.
- LIU H J, LU J P, LU G Q, et al. Clinical significance of ECG QRS wave group [J]. Journal of Practical Electrocardiology, 2016, 25 (1): 52–54.DOI: 10.13308/j.issn.2095-9354.2016.01.013.
- [14] 于万德, 程培培, 高晓飞, 等. QRS 波增宽的缺血性心肌病患者 PCI 术后 QRS 波时限及心功能变化的随访研究 [J]. 国际心血管病杂志, 2019, 46 (5): 305–308.DOI: 10.3969/j.issn.1673-6583.2019.05.013.
- YU W D, CHENG P P, GAO X F, et al. The changes of cardiac function and QRS duration in ischemic cardiomyopathy patients with prolonged QRS after PCI [J]. International Journal of Cardiovascular Disease, 2019, 46 (5): 305–308.DOI: 10.3969/j.issn.1673-6583.2019.05.013.
- [15] 司晓云, 周纬, 谌晶晶, 等. 希氏束起搏与右室心尖部起搏对老年患者心功能影响的对比分析 [J]. 心血管病学进展, 2019, 40 (7): 1052–1055.DOI: 10.16806/j.cnki.issn.1004-3934.2019.07.022.
- SI X Y, ZHOU W, SHEN J J, et al. A comparative study of cardiac function between hirschner bundle pacing and right ventricular apex pacing in elderly patients [J]. Advances in Cardiovascular Diseases, 2019, 40 (7): 1052–1055.DOI: 10.16806/j.cnki.issn.1004-3934.2019.07.022.
- [16] 张国荣. 急性心肌梗死患者心电图 QRS 波群时限与血浆 N-proBNP 水平及 LVEF 的相关性研究 [J]. 现代实用医学, 2016, 28 (2): 199–200.DOI: 10.3969/j.issn.1671-0800.2016.02.031.

(收稿日期: 2021-08-06; 修回日期: 2021-11-03)

(本文编辑: 李越娜)

(上接第 101 页)

- [19] 姜辉, 顾胜龙, 张玉婷, 等. 黄芪化学成分和药理作用研究进展 [J]. 安徽中医药大学学报, 2020, 39 (5): 93–96.
- [20] 王梦梦, 吉兰芳, 崔树娜. 丹参功效的物质基础研究进展 [J]. 中医学报, 2019, 34 (5): 944–949.DOI: 10.16368/j.issn.1674-8999.2019.05.225.
- WANG M M, JI L F, CUI S N. Advances in basic research on the efficacy of salvia miltiorrhiza [J]. China Journal of Chinese Medicine, 2019, 34 (5): 944–949.DOI: 10.16368/j.issn.1674-8999.2019.05.225.
- [21] 田国祥, 姚璐, 张薇, 等. 茜参益气滴丸对心脏后负荷增加大鼠不同阶段心脏全基因表达的影响 [J]. 中国循证心血管医学杂志, 2020, 12 (2): 160–166.DOI: 10.3969/j.issn.1674-4055.2020.02.09.
- TIAN G X, YAO L, ZHANG W, et al. Effect of Qishen Yiqi dropping pill on the expression of cardiac whole gene in rats with increased cardiac afterload at different stages [J]. Chinese Journal of Evidence-Bases Cardiovascular Medicine, 2020, 12 (2): 160–166.DOI: 10.3969/j.issn.1674-4055.2020.02.09.
- [22] 徐邦杰, 符德玉, 姚磊, 等. 活血潜阳祛痰方干预高血压前临床心衰阶段的临床研究 [J]. 上海中医药大学学报, 2019, 33 (4): 28–33.DOI: 10.16306/j.1008-861x.2019.04.004.
- XU B J, FU D Y, YAO L, et al. Clinical research on Huoxue Qianyang Qutan Formula in treating patients with hypertension at preclinical stage of heart failure [J]. Journal of Shanghai University of Traditional Chinese Medicine, 2019, 33 (4): 28–33.DOI: 10.16306/j.1008-861x.2019.04.004.
- [23] 王薇. 茜参益气滴丸在冠心病心功能不全治疗中的应用及对心功能影响的分析 [J]. 中西医结合心血管病电子杂志, 2019, 7 (10): 153–154.DOI: 10.16282/j.cnki.cn11-9336/r.2019.10.121.
- [24] 张凯旋, 耿巍, 田祥, 等. 茜参益气滴丸对慢性心力衰竭患者长期预后的影响 [J]. 中国医药导报, 2020, 17 (16): 125–128.
- ZHANG K X, GENG W, TIAN X, et al. Effect of Qishen Yiqi dropping pills on long-term prognosis of patients with chronic heart failure [J]. China Medical Herald, 2020, 17 (16): 125–128.

(收稿日期: 2021-08-09; 修回日期: 2021-11-16)

(本文编辑: 李越娜)