doi: 10.13241/j.cnki.pmb.2022.12.031

QRS、QT、QTc 及 LVEF 预测心源性猝死的价值分析 *

张 敏 李阳春 雷 蓉 杨 静 王 欢 王玉泉 王玉兵△

（川北医学院附属医院心内科 四川 南充 637000）

摘要 目的：探讨 QRS 时限值（QRS）、QT 间期延长（QT）、QTc 间期（QTc）及左室射血分数（LVEF）预测心源性猝死的价值分析。**方法：**选择 2018 年 1 月至 2019 年 12 月川北医学院附属医院心血管内科治疗的 356 例心源性猝死患者进行研究，设为病例组，并选择同期体检的健康人 200 例作为对照组，分析 QRS、QT、QTc 及 LVEF 水平变化情况及其预测价值。**结果：**病例组 QRS、QTc 水平显著高于对照组，QT、LVEF 水平显著低于对照组，差异显著（$P<0.05$）；轻度 QRS、QTc 显著低于中度、重度患者，QT、LVEF 水平显著高于中度、重度患者；中度患者 QRS、QTc 显著低于重度患者，QT、LVEF 水平显著高于重度患者，差异显著（$P<0.05$）；ROC 结果显示，QRS 预测心源性猝死的 AUC 为 0.989，灵敏度△ 为 84.59%，特异度为 87.68%，截断值为 115.59ms；QT 预测心源性猝死的 AUC 为 0.944，灵敏度 85.12%，特异度为 88.45%，截断值为 21.69ms；QTc 预测心源性猝死的 AUC 为 0.984，灵敏度为 86.05%，特异度为 88.61%，截断值为 416.39ms，LVEF 预测心源性猝死的 AUC 为 0.997，灵敏度 87.15%，特异度为 89.05%，截断值为 45.63%，（$P<0.05$）。**结论：**QRS、QT、QTc 及 LVEF 在心源性猝死患者中检查，可显著提高心源性猝死临床诊断效能。

关键词：QRS 时限值；QT 间期延长；QTc 间期；左室射血分数；心源性猝死；预测价值

中图分类号：R541.78；R540.41 **文献标识码：**A **文章编号：**1673-6273(2022)12-2352-04

Value Analysis of QRS, QT, QTc and LVEF in Predicting Sudden Cardiac Death*

ZHANG Min, LI Yang-chun, LEI Rong, YANG Jing, WANG Huan, WANG Yu-quan, WANG Yu-bing△

(Department of Cardiology, Affiliated Hospital of North Sichuan Medical University, Nanchong, Sichuan, 637000, China)

ABSTRACT Objective: To study Value analysis of QRS duration limit (QRS), QT interval prolongation (QT), QTc interval (QTc) and Left ventricular ejection fraction (LVEF) in predicting sudden cardiac death. **Methods:** 356 patients with sudden cardiac death treated in the Department of Cardiology, Affiliated Hospital of North Sichuan Medical College from January 2018 to December 2019 were selected as the case group, and 200 healthy subjects who underwent physical examination during the same period were selected as the control group. Changes in QRS, QT, QTc and LVEF levels and their predictive value were analyzed. **Results:** The levels of QRS and QTc in case group were significantly higher than those in control group, while the levels of QT and LVEF were significantly lower than those in control group ($P<0.05$). Mild QRS and QTc were significantly lower than moderate and severe patients, while QT and LVEF levels were significantly higher than moderate and severe patients. QRS and QTc in moderate patients were significantly lower than those in severe patients, while QT and LVEF levels were significantly higher than those in severe patients, the difference was significant ($P<0.05$). ROC results showed that THE AUC of QRS for predicting sudden cardiac death was 0.989, the sensitivity was 84.59%, the specificity was 87.68%, and the cut-off value was 115.59 ms. The AUC of QT for predicting sudden cardiac death was 0.944, the sensitivity was 85.12%, the specificity was 88.45% and the cut-off value was 21.69 ms. The AUC of QTc for predicting sudden cardiac death was 0.984, the sensitivity was 86.05%, the specificity was 88.61%, and the cutoff value was 416.39ms, while the AUC of LVEF for predicting sudden cardiac death was 0.997, the sensitivity was 87.15%, the specificity was 89.05%, and the cutoff value was 45.63% ($P<0.05$). **Conclusion:** QRS, QT, QTc and LVEF can significantly improve the clinical diagnostic efficiency of sudden cardiac death.

Key words: QRS time limit; Prolonged QT interval; QTc interphase; Left ventricular ejection fraction; Sudden cardiac death; Predictive value

Chinese Library Classification(CLC): R541.78; R540.41 Document code: A

Article ID:1673-6273(2022)12-2352-04

前言

心源性猝死指急性症状发作后 1 小时内发生的以意识突然丧失为特征的由心脏原因引起的自然死亡，发生率占总死亡

* 基金项目：四川省医学科研课题计划项目（Q160064）；南充市科技项目（19SXHZ0207）

作者简介：张敏（1978-），女，硕士，主治医师，研究方向：预警心源性猝死的无创心电指标，电话：13518296939，E-mail: yanghaiyuan198708@163.com

△ 通讯作者：王玉兵（1978-），女，博士，副主任医师，研究方向：心血管基础与临床，电话：13659080867，E-mail: 495720873@qq.com

（收稿日期：2021-11-23 接受日期：2021-12-19）

率的 1%~3.6%,在老年人猝死中占 90%以上,严重威胁人们的生命[1-3]。有研究显示,猝死多发生在医院外,医务人员难以第一时间到达,救治水平低,导致猝死者存活率低,因此,如何识别心源性猝死,预测疾病的发生对改善患者预后具有重要意义[4]。目前关于心源性猝死多预警指标,较多学者提出使用无创评估,其中无创评估主要包括心电图上的 QRS 波群时限及心室复极时限(QT、QTc)及 LVEF[5-7]。相关研究显示,多种心血管疾病患者存在心电图异常,且与患者心功能密切相关,而超声心动图可用于多种心脑血管疾病的预测,但其与心源性猝死相关性的报道较少[8]。因此,本研究旨在探讨 QRS、QT、QTc 及 LVEF 在心源性猝死中的变化,并分析其在预测心源性猝死中的价值。

1 资料与方法

1.1 一般资料

选择 2018 年 1 月至 2019 年 12 月川北医学院附属医院心血管内科治疗的 356 例心源性猝死患者进行研究,设为病例组,男 225 例,女 131 例,年龄 51～72 岁,平均(57.49±4.25)岁,根据左室射血分数分为重度组 (≤ 30%)80 例、中度组(31%~40%)123 例、轻度组(41%～49%) 153 例;选择我院同期体检的健康人 200 例作为对照组,男 115 例,女 85 例,年龄 50~69 岁,平均(57.35±4.18)岁。两组患者在年龄等一般资料无明显差异,具有可比性。

纳入标准:① 冠状动脉造影检查发现前降支为罪犯冠脉;② 临床病史、症状、实验室指标及影像学检查确诊;③ 后降支、右冠状动脉未出现完全闭塞;④ 知情同意。排除标准:① 近期接受过正规免疫调节剂治疗;② 沟通障碍者;③ 肝脏血管畸形、血管瘤等疾者;④ 日常生活能力丧失,完全依赖;⑤ 临床资料不全者;⑥ 伴有代谢或电解质紊乱者;⑦ 凝血功能障碍及血液系统病变者;⑧ 伴有间质性肺炎者。

1.2 方法与评价标准

采用美国 GE 公司 MAC5500 型 ECG 仪测定 QRS、QT、QTc 水平,采用超声诊断系统观察两组的 LVEF 水平。

1.3 统计学分析

以 SPSS 24.0 软件包处理,计量资料用均数±标准差($\bar{x}\pm s$)表示,t 检验,多组比较采用方差分析,使用受试者工作特征曲线(ROC)分析 QRS、QT、QTc 及 LVEF 的预测价值,P<0.05 为差异具有统计学意义。

2 结果

2.1 两组 QRS、QT、QTc 及 LVEF 水平比较

病例组 QRS、QTc 水平显著高于对照组,QT、LVEF 水平显著低于对照组,差异显著(P<0.05)见表 1。

表 1 两组 QRS、QT、QTc 及 LVEF 水平比较($\bar{x}\pm s$)

Table 1 Comparison of QRS, QT, QTc and LVEF levels between the two groups($\bar{x}\pm s$)

Groups	n	QRS(ms)	QT(ms)	QTc(ms)	LVEF(%)
Case group	356	132.25±10.67	16.41±4.41	454.67±10.52	36.25±4.12
Control group	200	104.21±6.23	25.36±3.47	391.22±9.35	59.34±5.67
t value		34.039	24.719	70.983	55.177
P value		0.000	0.000	0.000	0.000

2.2 不同疾病严重程度 QRS、QT、QTc 及 LVEF 水平比较

轻度 QRS、QTc 显著低于中度、重度患者,QT、LVEF 水平显著高于中度、重度患者;中度患者 QRS、QTc 显著低于重度患者,QT、LVEF 水平显著高于重度患者,差异显著(P<0.05)见表 2。

表 2 不同疾病严重程度 QRS、QT、QTc 及 LVEF 水平比较($\bar{x}\pm s$)

Table 2 Comparison of QRS, QT, QTc and LVEF levels in different disease severity($\bar{x}\pm s$)

Groups	n	QRS(ms)	QT(ms)	QTc(ms)	LVEF(%)
Mild	153	110.14±6.15	20.15±4.45	397.41±9.78	43.48±3.18
Moderate	123	128.52±10.63	14.58±4.67	433.42±10.51	32.89±5.08
SSevere	80	180.27±12.55	12.07±5.06	596.85±11.56	27.58±4.25
F value		1440.484	93.118	9949.797	444.683
P value		0.000	0.000	0.000	0.000

2.3 QRS、QT、QTc 及 LVEF 预测心源性猝死的价值分析

ROC 结果显示,QRS 预测心源性猝死的 AUC 为 0.989,灵敏度为 84.59%,特异度为 87.68%,截断值为 115.59 ms;QT 预测心源性猝死的 AUC 为 0.944,灵敏度 85.12%,特异度为 88.45%,截断值为 21.69 ms;QTc 预测心源性猝死的 AUC 为 0.984,灵敏度为 86.05%,特异度为 88.61%,截断值为 416.39 ms,LVEF 预测心源性猝死的 AUC 为 0.997,灵敏度 87.15%,特异度为 89.05%,截断值为 45.63%,(P<0.05)见图 1、表 3。

3 讨论

猝死是一种出乎意料的死亡现象,心源性猝死是由心脏病引起的突然死亡状况,临床过程可分为 4 期,其中在发病前数

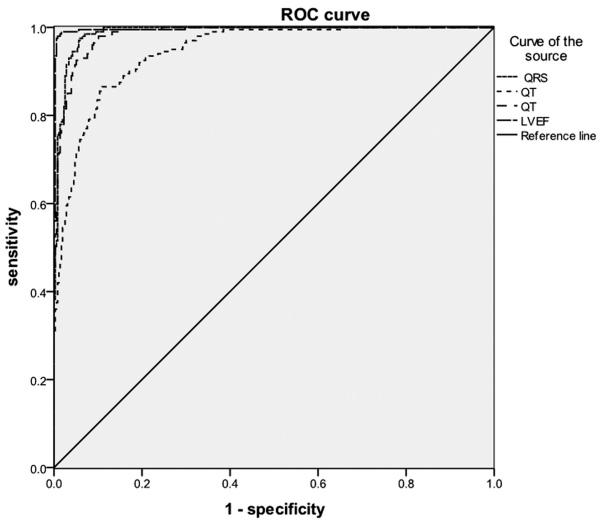

图 1 QRS、QT、QTc 及 LVEF 预测心源性猝死的 ROC 曲线

Fig. 1 ROC curves of QRS, QT, QTc and LVEF for predicting sudden cardiac death

极延迟，反映了心电异常[27-31]。LVEF 是最常用、最重要的左心室收缩功能指标，对判断心功能状态及病情预后有重要意义[32,33]。有研究显示，LVEF 与心源性猝死有相关性，且 LVEF 越低，心室重构越明显，心肌细胞越少，则死亡率越高[34]。心源性猝死患者 QRS、QTc 水平显著高于健康人，QT、LVEF 水平显著低于健康人群，且轻度 QRS、QTc 显著低于中度、重度患者，QT、LVEF 水平显著高于中度、重度患者；中度患者 QRS、QTc 显著低于重度患者，QT、LVEF 水平显著高于重度患者，结果提示，心源性猝死患者 QRS、QT、QTc 及 LVEF 等心电图水平异常，且可随着疾病的严重程度而发生变化，与心源性猝死的发生关系密切。Chaudhary A[35]等研究也显示，通过监测心电图水平对心力衰竭患者病情进行评估。分析其原因可能是因为心源性猝死患者多伴有心肌重塑，可导致患者心室电传导障碍，因此临床上可通过监测 QRS、QT、QTc 及 LVEF 来对患者病情进行评估。本研究进一步 ROC 分析结果显示，QRS 预测心源性猝死的 AUC 为 0.989，截断值为 115.59 ms；QT 预测心源性猝死的 AUC 为 0.944，截断值为 21.69 ms；QTc 预测心源性猝死的 AUC 为 0.984，截断值为 416.39 ms，LVEF 预测心源性猝死的 AUC 为 0.997，截断值为 45.63%，结果提示，QRS、QT、QTc 及 LVEF 用于测心源性猝死具有较高的灵敏度和特异度，可用于对心源性猝死的预测。但本研究样本量相对较少，未能对患者预后与心功能的相关性得出确切结论，下一步我们将加强对此方面的深入研究。

表 3 QRS、QT、QTc 及 LVEF 预测心源性猝死的价值分析

Table 3 Value analysis of QRS, QT, QTc and LVEF in predicting sudden cardiac death

Items	AUC(95%CI)	Standard error	*P*	The sensitivity	Specific degrees	Cutoff value
QRS	0.989(0.982~0.995)	0.003	0.000	84.59	87.68	115.59ms
QT	0.944(0.927~0.962)	0.009	0.000	85.12	88.45	21.69ms
QTc	0.984(0.977~0.992)	0.004	0.000	86.05	88.61	416.39ms
LVEF	0.997(0.993~1.000)	0.002	0.000	87.15	89.05	45.63%

天可出现胸痛、气促、乏力等症状；到终末期可表现出严重胸痛，急性呼吸困难，突发心悸或眩晕等；到心脏骤停期表现出突然的意识丧失常，伴有惊厥，大动脉搏动消失，脉搏扪不到，听诊心音消失等；而在心脏骤停发生后，多数患者在 4～6 分钟内发生不可逆脑损害，经数分钟过渡到生物学死亡[9-12]。心源性猝死发病机制较为复杂，导致其发生的主要因素包括心肌病、冠心病、心脏瓣膜病症等，其中心肌病症是由于心室结构的改变，及心肌壁的功能受到损伤引起的临床病症[13,14]。有研究显示，部分心脏性猝死是室性快速心律失常所致，同时心电不稳定、冠状动脉痉挛、心肌缺血等均可使稳定的心脏结构异常，从而发生不稳定情况，且自主神经系统不稳定、电解质失调等则可触发心脏性猝死，我国每年超过 50 万人死于心源性猝死，居世界之首，严重威胁人们的生命[15-17]。因此，如何识别心源性猝死，并防治猝死的发生是当今临床医学难题。

心电图具有操作简单、价格低等优势，能间接提示病变程度，反映心电紊乱情况，被用于心血管疾病的早期检测[18-20]。QRS、QT、QTc 及 LVEF 是常见的无创心电指标，其中 QRS 反映全部心室激动过程所需要的时间，在正常人中 QRS 波群时限为 0.06~0.10s，其增宽可引起心室激动不同步，导致心功能下降，同时还提示室内传导减慢，促发室性心律失常，可作为传导延迟的简单衡量指标[21-25]。有研究显示，QRS 容易与正常的心肌建立电传导，产生了折返激动，导致了心律失常的发生[26]。QT 指 QRS 波群起点至 T 波终点的长度，反映心室的去极化 - 复极化的总体过程，与心室心肌细胞动作电位存在关系，QTc 是反映心脏去极化和复极作用的指标，QTc 间期延长表示心脏复

综上所述，QRS、QT、QTc 及 LVEF 在心源性猝死患者中检查，可显著提高心源性猝死临床诊断效能。临床可根据以上指标提供线索，早期评估，对高危患者给予有效干预，提高患者的生存率。

参 考 文 献(References)

[1] Grubic N, J Puskas, Phelan D, et al. Shock to the Heart: Psychosocial Implications and Applications of Sudden Cardiac Death in the Young [J]. Current Cardiology Reports, 2020, 22(12): 1-11

[2] Paratz E D, Rowsell L, Zentner D, et al. Cardiac arrest and sudden cardiac death registries: a systematic review of global coverage [J]. Open Heart, 2020, 7(1): e001195

[3] Han H C, Parsons S A, Teh A W, et al. Characteristic Histopathological Findings and Cardiac Arrest Rhythm in Isolated Mitral Valve Prolapse and Sudden Cardiac Death [J]. Journal of the American Heart Association, 2020, 9(7): e015587

[4] Lai D, Zhang Y, Zhang X, et al. An Automated Strategy for Early Risk Identification of Sudden Cardiac Death by Using Machine Learning Approach on Measurable Arrhythmic Risk Markers [J]. IEEE Access, 2019, PP(99): 1-1

[5] Khan H M, Leslie S J. Risk factors for sudden cardiac death to

determine high risk patients in specific patient populations that may benefit from a wearable defibrillator[J]. World Journal of Cardiology, 2019, 11(03): 13-29

[6] Micaglio E, Monasky M M, Bernardini A, et al. Clinical Considerations for a Family with Dilated Cardiomyopathy, Sudden Cardiac Death, and a Novel TTN Frameshift Mutation [J]. International Journal of Molecular Sciences, 2021, 22(2): 670

[7] Pavon A G, Monney P, Schwitter J. Mitral Valve Prolapse, Arrhythmias, and Sudden Cardiac Death: The Role of Multimodality Imaging to Detect High-Risk Features[J]. Diagnostics, 2021, 11(4): 683

[8] Kondou H, Bandou R, Ichioka H, et al. The coronary artery calcification severity on postmortem CT could be a clue for the diagnosis of sudden cardiac death [J]. Journal of Forensic and Legal Medicine, 2021, 82(4): 102227

[9] Coppola P, Cicero A, Fogacci F, et al. Laboratory and Instrumental Risk Factors Associated with a Sudden Cardiac Death Prone ECG Pattern in the General Population: Data from the Brisighella Heart Study[J]. Journal of Clinical Medicine, 2021, 10(4): 640

[10] Sakhi R, Assaf A, Theuns D, et al. Outcome of Insertable Cardiac Monitors in Symptomatic Patients with Brugada Syndrome at Low Risk of Sudden Cardiac Death[J]. Cardiology, 2020, 145(7): 1-8

[11] Mareev V Y, Mareev Y V. Influence of Omega-3 PUFA on Non-invasive factors determining the risk of arrhYthmias eXcess and sudden cardiac death in patients with HFpEF with ischemic etiology (ONYX)[J]. Kardiologiia, 2020, 60(10): 86-98

[12] Kosmas N, Manolis A S, Dagres N, et al. Myocardial infarction or acute coronary syndrome with non-obstructive coronary arteries and sudden cardiac death: A missing connection [J]. Europace, 2020, 22 (9): 1303-1310

[13] Payne T, Waller J, Kh Eda M, et al. Efficacy of Implantable Cardioverter-defibrillators for Secondary Prevention of Sudden Cardiac Death in Patients with End-stage Renal Disease[J]. Journal of Innovations in Cardiac Rhythm Management, 2020, 11(8): 4199-4208

[14] Valappil S, Rajesh G N, Vellani H. Prevalence of Risk Factors for Sudden Cardiac Death among Patients with Hypertrophic Cardiomyopathy in a Tertiary Care Centre in South India [J]. Journal of Evidence Based Medicine and Healthcare, 2020, 7(40): 2237-2241

[15] Iglesias M, Ripoll-Vera T, Perez-Luengo C, et al. Diagnostic Yield of Genetic Testing in Sudden Cardiac Death with Autopsy Findings of Uncertain Significance[J]. Journal of Clinical Medicine, 2021, 10(9): 1806

[16] Palacios-Rubio J, Roessel M V, Galizia-Brito V, et al. Outcome of Insertable Cardiac Monitors in Symptomatic Patients with Brugada Syndrome at Low Risk of Sudden Cardiac Death [J]. Cardiology, 2020, 146(1): 1-2

[17] Hallak Y. Cardiac Screening To Mitigate The Risk Of Sudden Cardiac Death In Middle Eastern And African Competitive Athletes. A Systematic Review [J]. Journal of the Saudi Heart Association, 2020, 32(2): 174-185

[18] Shomanova Z, Ohn Ew Ein B, Schernthaner C, et al. Classic and Novel Biomarkers as Potential Predictors of Ventricular Arrhythmias and Sudden Cardiac Death [J]. Journal of Clinical Medicine, 2020, 9 (2): 578

[19] Sueda S, Shinohara T, Takahashi N, et al. Clinical Therapy in Patients with Aborted Sudden Cardiac Death due to Coronary Spasm [J]. Journal of Coronary Artery Disease, 2020, 26(4): 91-99

[20] Tan A Y, Ellenbogen K A. Separating the Forest From the Trees: New Tools for a Personalized Sudden Cardiac Death Risk Stratification [J]. Journal of the American Heart Association, 2020, 9 (20): e018957

[21] Scolari F L, Garbin H I, Mattos B. Discrepancy between International Guidelines on the Criteria for Primary Prevention of Sudden Cardiac Death in Hypertrophic Cardiomyopathy [J]. Arquivos Brasileiros de Cardiologia, 2020, 115(2): 197-204

[22] Schmidt E B, Calder P C. Marine n-3 Fatty Acids, Sudden Cardiac Death, and Ischemic Heart Disease: Fish or Supplements?[J]. Journal of Nutrition, 2020, 150(12): 3055-3057

[23] Kauppila J P, Pakanen L, Porvari K, et al. Blood alcohol levels in Finnish victims of non-ischaemic sudden cardiac death [J]. Annals of Medicine, 2021, 53(1): 413-419

[24] Wu Q, Li F, Jia Y, et al. Physical activity and risk of sudden cardiac death in individuals at high risk for cardiovascular disease: A protocol for systematic review and meta-analysis[J]. Medicine, 2021, 100(19): e25890

[25] Niebauer J, Burtscher M. Sudden Cardiac Death Risk in Downhill Skiers and Mountain Hikers and Specific Prevention Strategies [J]. International Journal of Environmental Research and Public Health, 2021, 18(4): 1621

[26] D Hernández-Romero, MDR Valverde-Vázquez, JPHD Rincón, et al. Diagnostic Application of Postmortem Cardiac Troponin I Pericardial Fluid/Serum Ratio in Sudden Cardiac Death[J]. Diagnostics, 2021, 11 (4): 614

[27] Akay M, S Yüksel. Resuscitated sudden cardiac death due to severe hypokalemia caused by teff grain herbal tea: A case report [J]. Turk Kardiyoloji Dernegi Arsivi-Archives of the Turkish Society of Cardiology, 2020, 48(6): 623-626

[28] Sueda S. Optimal Medical or Mechanical Treatment for Patients with Aborted Sudden Cardiac Death due to Coronary Spasm[J]. Journal of Coronary Artery Disease, 2020, 26(2): 17-23

[29] Rashid A. Yonder: Autism, home visits, suicidal ideation, and young sudden cardiac death[J]. British Journal of General Practice, 2021, 71 (704): 129-129

[30] Zaitsev D N, Vasilenko P V, Govorin A V, et al. 2017-2019 Sudden cardiac death registry of the Zabaykalsky Krai population (ZODIAC) [J]. Russian Journal of Cardiology, 2020, 25(11): 3997

[31] Tan H L, Van D, Smits R, et al. Can we better understand sudden cardiac death by including data from unwitnessed victims? [J]. EP Europace, 2021(6): 6

[32] Smith A, Iqbal O J. Mitral valve prolapse and sudden cardiac death: A perspective on risk-stratification [J]. Cleveland Clinic Journal of Medicine, 2020, 87(3): 136-138

[33] Alam Y S, Aljabry K, H Nafakhi, et al. ECG markers of sudden cardiac death among body mass index groups [J]. Annals of Tropical Medicine and Public Health, 2020, 23(6): 08-12

[34] Yamin M, Demili A U. Prevention of Ventricular Arrhythmia and Sudden Cardiac Death in COVID-19 Patients [J]. Acta medica Indonesiana, 2020, 52(3): 290-296

[35] Chaudhary A, Kadel T, Wasti H, et al. Spectrum of sudden cardiac death in Nepalese population - an institutional based study [J]. Sri Lanka Journal of Forensic Medicine Science & Law, 2020, 11(2): 26