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QRS Duration and Early Hemodynamic Instability After Coronary Revascularization Surgery

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Introduction and objectives. The duration of the QRS interval measured by ECG is a marker of ventricular dysfunction and indicates a poor prognosis. Its value in patients undergoing coronary revascularization surgery has not been established.

Methods. The study involved 203 consecutive patients (age, 64[9] years; 74% male) scheduled for elective coronary surgery. The maximum QRS duration measured on a preoperative 12-lead ECG was recorded. Hemodynamic instability was defined as the occurrence of cardiac death, heart failure, or a need for intravenous inotropic drugs or intra-aortic balloon counterpulsation during the postoperative period.

Results. The occurrence of hemodynamic instability (n=94, 46%) was associated with a longer preoperative QRS duration (97.5[21.14] ms vs 88.5[16.9] ms; *P*=.001). The QRS duration was also longer in patients who developed heart failure (n=23; 104.3[22.9] ms vs 91.1[18.5] ms; *P*=.002), needed inotropic drugs (n=77; 96.5[20.5] ms vs 90.1[18.2] ms; *P*=.007) or developed postoperative atrial fibrillation (n=58; 98.2[23.8] ms vs 90.4[17.0] ms; *P*=.018). Bundle branch block was associated with a greater need for intra-aortic balloon counterpulsation (29% vs 12%; *P*=.012) or inotropic drugs (58% vs 35%; *P*=.014) and a higher incidence of hemodynamic instability (69% vs 42%; *P*=.006). Multivariate analysis identified the following independent predictors of hemodynamic instability: QRS duration (adjusted odds ratio [OR] per 10 ms=1.49; 95% confidence interval [CI], 1.11-2; *P*=.007), the lack of an arterial graft (OR=3.6; 95% CI, 1.14-11.6; *P*=.029) and extracorporeal circulation time (OR per min=1.013; 95% CI, 1.003-1.023; *P*=.013).

Conclusions. The intraventricular conduction delay, or QRS duration, was associated with a higher risk of postoperative hemodynamic instability following coronary surgery.

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Duración del QRS y deterioro hemodinámico precoz tras cirugía de revascularización coronaria

Introducción y objetivos. La duración del intervalo QRS en el ECG es un marcador de disfunción ventricular y peor pronóstico. Su valor en pacientes sometidos a cirugía de revascularización coronaria no ha sido establecido.

Métodos. Estudiamos a 203 pacientes consecutivos (64 ± 9 años de edad; el 74% varones) programados para cirugía electiva coronaria. Se registró la duración máxima del intervalo QRS en el ECG de 12 derivaciones preoperatorio. Definimos inestabilidad hemodinámica como la aparición de muerte cardiaca, insuficiencia cardiaca, uso de fármacos inotrópicos intravenosos o balón de contrapulsación intraaórtico durante el postoperatorio.

Resultados. La aparición de inestabilidad hemodinámica (n = 94 [46%]) se asoció a una mayor duración del intervalo QRS preoperatorio (97,5 ± 21,14 frente a 88,5 ± 16,9 ms; p = 0,001). El QRS fue mayor en quienes apareció insuficiencia cardiaca (n = 23; 104,3 ± 22,9 frente a 91,1 ± 18,5 ms; p = 0,002), precisaron inotrópicos intravenosos (n = 77; 96,5 ± 20,5 frente a 90,1 ± 18,2 ms; p = 0,007) o sufrieron fibrilación auricular postoperatoria (n = 58; 98,2 ± 23,8 frente a 90,4 ± 17 ms; p = 0,018). El bloqueo de rama se asoció a mayor necesidad de balón de contrapulsación (el 29 frente al 12%; p = 0,012), inotrópicos (el 58 frente al 35%; p = 0,014) y mayor incidencia de inestabilidad hemodinámica (el 69 frente al 42%; p = 0,006). Tras el ajuste multivariable, los predictores de inestabilidad hemodinámica fueron la duración del QRS (*odds ratio* [OR] = 1,49; intervalo de confianza [IC] del 95%, 1,11-2; p = 0,007), la ausencia de injerto arterial (OR = 3,6; IC del 95%, 1,14-11,6; p = 0,029) y el tiempo de circulación extracorpórea (OR = 1,013; IC del 95%, 1,003-1,023; p = 0,013), con independencia de otros factores de riesgo.

Conclusiones. El retraso de la conducción intraventricular o duración del intervalo QRS se asocia a mayor riesgo de inestabilidad hemodinámica durante el postoperatorio de cirugía coronaria.

ABBREVIATIONS

CBBB: complete bundle branch block
CPB: cardiopulmonary bypass
ECG: electrocardiogram
IABC: intra-aortic balloon counterpulsation
LIMA: left internal mammary artery
LVEF: left ventricular ejection fraction

Palabras clave: *Cirugía coronaria. Intervalo QRS. ECG. Pronóstico. Inestabilidad hemodinámica.*

INTRODUCTION

Intraventricular conduction delay, manifested as a prolongation of the QRS complex on the surface electrocardiogram (ECG), has been shown to be of prognostic value in patients with structural heart disease. For example, in cases of acute myocardial infarction involving ventricular dysfunction[1,2] and in chronic heart failure,[3-5] its prognostic value has been well established. More recent studies have pointed out its prognostic value in patients with stable coronary artery disease and preserved left ventricular ejection fraction (LVEF),[6,7] in those with hypertrophic cardiomyopathy,[8] in patients with pacemakers[9] or implantable cardioverter-defibrillators,[10] and even in patients with no structural heart disease in a general population.[11] In recent years, it has been shown that the correction of the asynchrony associated with prolonged QRS duration by means of biventricular pacing results in a significant clinical benefit in patients with systolic heart failure.[12,13]

There is little data concerning the field of coronary revascularization surgery, and that available refers to the changes that take place in the QRS complex during the perioperative and postoperative periods.[14-17] QRS prolongation occurs quite frequently during the postoperative period following surgery for myocardial revascularization, with incidences ranging between 4% and 50%, depending on the series.[14-16] This phenomenon is associated with higher concentrations of the creatine kinase MB fraction (CK-MB), but not with other clinical complications or a poorer short-term or long-term prognosis.[14-16] A recent meta-analysis has corroborated this absence of a clinical impact both over the short and the long term.[17] On the other hand, the value of QRS duration on the preoperative ECG has been assessed in fewer studies[18-20] and has been associated with the development of low postoperative cardiac output in the presence of ventricular systolic dysfunction,[18] heart arrest during the immediate postoperative period,[19] and long-term adverse events.[20]

We designed an observational clinical study to evaluate whether the duration of the QRS interval on the preoperative ECG determines the development of hemodynamic deterioration and/or adverse clinical events during the early postoperative period following elective coronary revascularization surgery.

METHODS

Study Population

We performed a prospective study in 203 consecutive patients who underwent elective coronary revascularization surgery between 2002 and 2003 in 2 tertiary hospitals. Emergency procedures, coronary reoperations and combined procedures (coronary and valve surgery, coronary and vascular surgery, or coronary surgery and resection of ventricular aneurysms) were excluded. The day before the surgical intervention, all the patients underwent a preoperative study that included: standard 12-lead resting ECG, with automatic measurement at 50 mm/s (PageWriter 100, Hewlett Packard, Cupertino, California, United States) and the recording of the preoperative clinical characteristics. The preoperative ECG enabled the determination of the maximum duration of the QRS interval and whether there was a His bundle branch block, according to previously described criteria.[21] The clinical characteristics recorded as preoperative variables were: sex, age, diabetes mellitus, hypertension, dyslipidemia, smoking, family history of ischemic heart disease, preoperative left ventricular ejection fraction (LVEF), acute myocardial infarction, recent acute coronary syndrome (within the preceding 30 days), peripheral arterial disease, coronary angioplasty, previous paroxysmal atrial fibrillation, heart failure, and chronic obstructive pulmonary disease. The additive EuroSCORE scale, the presence of sinus rhythm, the New York Heart Association (NYHA) functional class, the number of diseased coronary vessels per patient, the presence of left main coronary disease, and drug therapy were recorded for each patient. All the patients provided their written informed consent for the study.

Surgical Procedure

The median sternotomy approach was employed in every case. Left internal mammary artery (LIMA)

and internal saphenous vein were used for the grafts. In those patients who underwent revascularization with extracorporeal circulation, the cardiopulmonary bypass (CPB) was performed with cannulation of ascending aorta and a single cannula in right atrium for venous return. The standard CPB circuit was employed (Cobe Cardiovascular Inc., Colorado, United States), with 40-μ filters (Sorin Biomedica, Saluggia, Italy); a Dideco D903 Avant membrane oxygenator (Dideco srl, Mirandola, Italy) was used. Pulsatile flow was utilized with mean flow velocities of 2.4 L/m^2/min. The systemic temperature was lowered to between 28ºC and 32ºC (moderate hypothermia). Myocardial protection was achieved using antegrade and retrograde hyperkalemic cold blood cardioplegia. In the population that underwent surgery without CPB, the exposure of the vessel in which the graft was to be anastomosed was carried out by means of a CTS stabilizer (Guidant, Indianapolis, Indiana, United States).

Among the operative data, we recorded the use of CPB for the revascularization surgery, the use of arterial grafts, the number of grafts per patient, the myocardial ischemic time (in minutes), and the CPB time (in minutes). For the analysis of the CPB and myocardial ischemic times, they were quantified as zero minutes in the patients who did not undergo CPB.

Events

The patients were monitored throughout the first 30 days after the intervention. The major event, hemodynamic instability, was defined as that involving one of the following adverse events: *a)* cardiac death defined as that secondary to asystole, ventricular fibrillation, acute heart failure, sudden death, or any other cardiac-related death according to the clinical report; *b)* heart failure defined as the recording of clinical and/or radiological data indicative of left, and/or right heart failure during the postoperative period that required the initiation of treatment with oral or intravenous diuretics or vasodilators; *c)* the need for intravenous inotropic drugs (in inotropic doses, dobutamine over 5 μg/kg/min) in the intensive care unit for more than 24 hours; and *d)* need for intra-aortic balloon counterpulsation (IABC) at any time during the surgical or postoperative process. We recorded the development of any episode of atrial fibrillation during the postoperative period according to previously described criteria.[22] The length of the stay in the intensive care unit (in days) and the total length of the hospital stay (in days) were also recorded.

Statistical Analysis

The continuous variables showing a normal distribution are expressed as the mean (standard deviation) and were compared using the Student *t* test; variables whose distribution was not normal are expressed as medians and quartiles, and were compared by means of with Mann-Whitney *U* test. Categorical variables are shown as frequencies and percentages and were compared using the χ^2 test or Fisher's exact test, as required. For the study of predictors of the major composite event, logistic regression analysis was performed for every possible baseline risk factor. Multivariate logistic regression analysis (conditional forward step method) included the significant or nearly significant factors ($P<.10$) in univariate analysis; in addition, the results were adjusted for age, sex, and possible confounding factors (center, number of diseased vessels, history of previous atrial fibrillation, and systolic dysfunction). The statistical analysis was carried out using the SPSS 15.0 software package for Windows (SPSS Inc., Chicago, Illinois, United States). A *P* value less than .05 was considered to indicate statistical significance.

RESULTS

QRS and Baseline Characteristics

The mean duration of the preoperative QRS interval was 92.6 (19.4) milliseconds, with a median [interquartile interval] of 90 [80 to 100] milliseconds. Table 1 shows the characteristics of the population distributed according to the median QRS duration (90 milliseconds). The duration of the QRS interval was longer in the patients with a preoperative history of paroxysmal atrial fibrillation (112 [28.3] milliseconds vs 91.4 [18.2] milliseconds; $P=.002$) and left ventricular systolic dysfunction (LVEF <40%) (100 [18.4] vs 91.4 [19.4]; $P=.011$). Likewise, a longer QRS duration correlated with a larger number of diseased vessels per patient ($P=.015$; $r=0.171$), a larger number of grafts per patient ($P=.033$; $r=0.150$), a longer CPB time ($P=.016$; $r=0.201$), and a longer myocardial ischemic time ($P=.001$; $r=0.269$). Thirty-two patients (16%) presented criteria for complete bundle branch block (CBBB). The QRS categorized as CBBB (over 120 milliseconds) was associated with a greater utilization of CPB for myocardial revascularization (78% vs 56%; $P=.020$), a larger number of grafts per patient (2.36 [0.941] vs 2.66 [1.12]; $P=.059$), a longer myocardial ischemic time (44.8 [29.9] vs 26.2 [30.3] minutes; $P=.006$) and a longer CPB time (93.7 [50.6] vs 56.3 [49.8] minutes; $P=.001$).

QRS and Events

Within the first 30 days, 94 patients (46%) developed the major event or hemodynamic instability; 5

TABLE 1. **Characteristics of the Population Distributed According to the Median Duration of the QRS Interval**

Variables	Total (n=203)	QRS ≥90 ms (n=103)	QRS <90 ms (n=100)	*P*
Age, mean (SD), y	64.4 (9.3)	65 (9.6)	63.7 (8.9)	.259
>70 years, n (%)	37 (26)	37 (36)	30 (30)	.370
Men, n (%)	151 (74)	79 (77)	72 (72)	.443
Diabetes mellitus, n (%)	79 (39)	42 (41)	37 (37)	.581
Hypertension, n (%)	126 (62)	66 (64)	60 (60)	.549
Hypercholesterolemia, n (%)	120 (59)	60 (58)	60 (60)	.800
Smoking, n (%)	49 (24)	26 (25)	23 (23)	.709
Previous AMI, n (%)	82 (42)	42 (41)	40 (40)	.910
Recent ACS (<1 month), n (%)	121 (60)	63 (62)	58 (58)	.526
Beta-blockers, n (%)	154 (76)	81 (79)	73 (73)	.403
Acetylsalicylic acid, n (%)	183 (90)	90 (87)	93 (93)	.072
Statins, n (%)	126 (62)	64 (62)	62 (62)	.913
Peripheral vascular disease, n (%)	16 (8)	9 (9)	7 (7)	.454
LVEF, mean (SD), %	55.6 (11.7)	53.8 (12.6)	57.1 (10.7)	.153
<40%, n (%)	29 (14)	20 (19)	9 (9)	.034
Atrial fibrillation, n (%)	12 (6)	11 (11)	1 (1)	.003
Heart failure, n (%)	24 (12)	15 (15)	9 (9)	.210
COPD, n (%)	7 (3.4)	3 (3)	4 (4)	.786
Additive EuroSCORE, mean (SD)	3.5 (3.1)	3.5 (3.2)	3.4 (3)	.928
Diseased vessels/patient, mean (SD), n	2.6 (0.5)	2.6 (0.5)	2.5 (0.5)	.116
LMC disease, n (%)	76 (34)	36 (35)	40 (40)	.391
Surgery with CPB, n (%)	121 (60)	62 (60)	59 (59)	.862
Grafts/patient, mean (SD), n	2.3 (0.9)	2.3 (1)	2.3 (0.8)	.877
CPB time, mean (SD), min	62.6 (51.5)	65 (53)	60.1 (49.8)	.612
Myocardial ischemic time, mean (SD), min	29.3 (30.9)	33.1 (32.8)	25.4 (28.6)	.138
Use of arterial graft, n (%)	162 (79)	75 (74)	83 (83)	.320
Hospital 1, n (%)	90 (44)	43 (42)	47 (47)	.451
Hospital 2, n (%)	113 (56)	53 (53)	60 (58)	.451

ACS indicates acute coronary syndrome; AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; CPB, cardiopulmonary bypass; LMC, left main coronary; LVEF, left ventricular ejection fraction; SD, standard deviation.

(2.5%) died, 77 (38%) required intravenous amines at inotropic doses for more than 24 hours, 29 (14%) required IABC at some time during the postoperative period, and 23 (11%) developed heart failure. Hemodynamic instability was associated with a longer stay in the intensive care unit (4 [3-7] vs 3 days [2-3.75]; *P*=.0001) as well as with a longer hospital stay (19 [10.75-31.5] vs 10 days [8-14]; *P*=.001)

The QRS duration was longer in patients who required intravenous inotropics (96.5 [20.5] vs 90 [18.2]; *P*=.007), developed postoperative heart failure (104.3 [22.9] vs 91.18 [18.5]; *P*=.002) and experienced postoperative atrial fibrillation (98.2 [23.8] vs 90.4 [17]; *P*=.018), although it was not significant enough to require IABC (97 [20.3] vs 91.8 [19.1]; *P*=.075). The development of hemodynamic instability during the early postoperative period was associated with a longer duration of the QRS interval on the preoperative ECG (97.5 [21.1] vs 88.5 [16.9]; *P*=.001) (Figure 1) and had a linear association with the distribution of the QRS duration by terciles (*P*<.001) (Figure 2). As shown in Table 2, hemodynamic instability occurred more frequently in the presence of CBBB, when fewer arterial grafts were used in the revascularization, when the myocardial ischemic time was longer and when the CPB time was longer. Patients with and without hemodynamic instability did not differ in terms of the preoperative LVEF (60 [50-62] vs 57 [50-61.5]; *P*=.840) or the additive EuroSCORE (3 [0-6] vs 4 [0-5]; *P*=.954). Moreover (Figure 3), among the patients with preoperative CBBB, there was a significantly higher incidence of hemodynamic instability (69% vs 42%; *P*=.006), IABC (29% vs 12%; *P*=.012) and use of intravenous inotropics (58% vs 35%; *P*=.014) during the postoperative period. The preoperative QRS interval, as the total duration or as CBBB, was not associated with a higher mortality rate (*P*=.301 and *P*=.792, respectively).

Multivariate analysis

After multivariate adjustment in logistic regression analysis for the onset of hemodynamic instability during the early postoperative period (Table 3), the independent predictors were a longer duration

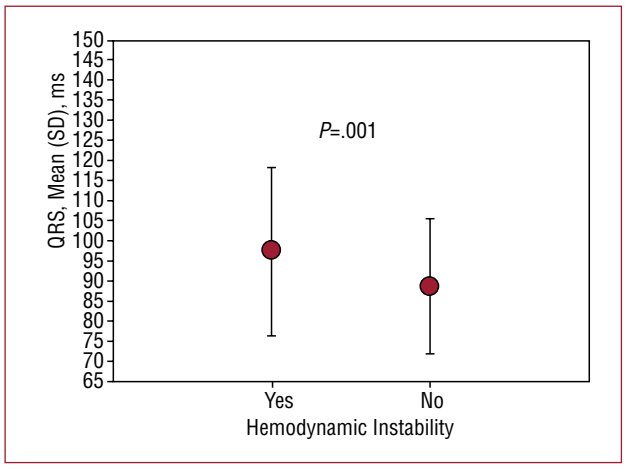

Figure 1. QRS duration in patients with and without hemodynamic instability during the early postoperative period. SD indicates standard deviation.

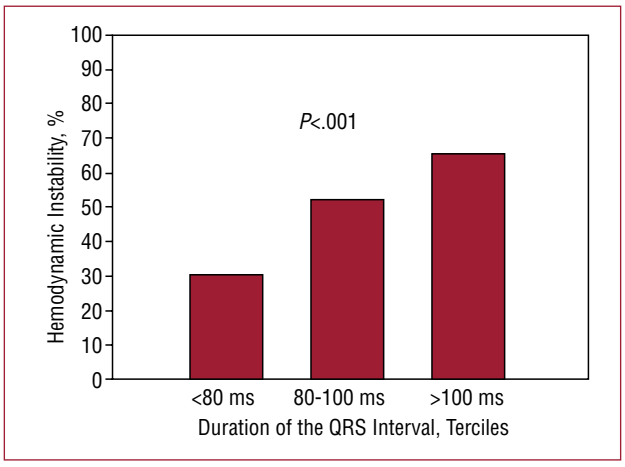

Figure 2. Incidence of hemodynamic instability according to the distribution of the QRS interval by terciles.

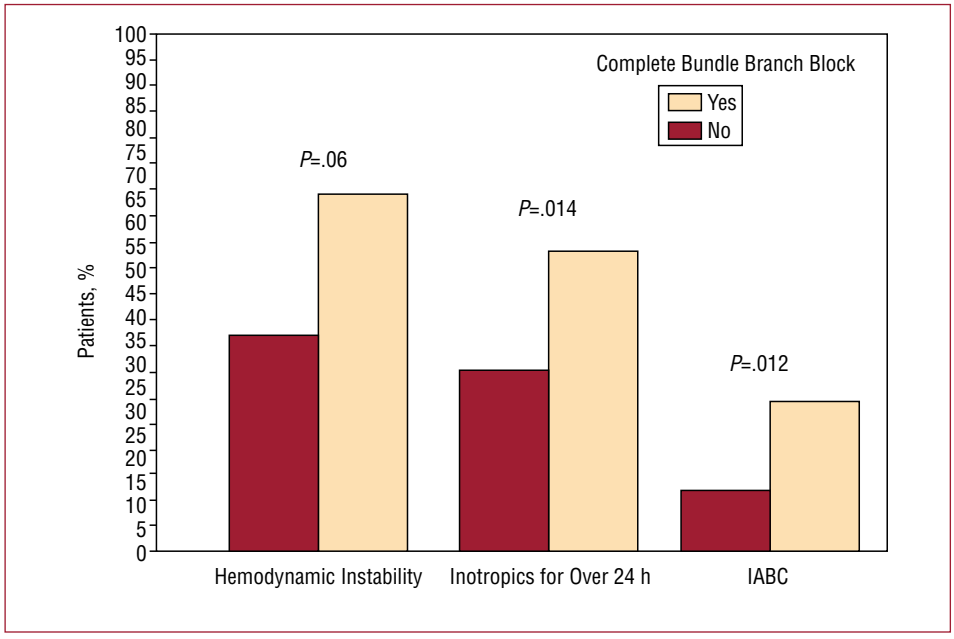

Figure 3. Incidence of hemodynamic instability, need for intravenous amines and intraaortic balloon counterpulsation (IABC) in patients with and without complete bundle branch block.

of the QRS interval (adjusted odds ratio [OR] per 10 milliseconds = 1.49; 95% confidence interval [95% CI], 1.11-2; *P*=.007), the absence of arterial grafts in coronary revascularization (OR=3.6; 95% CI, 1.14-11.6; *P*=.029) and a longer CPB time (per minute, OR=1.013; 95% CI, 1.003-1.023; *P*=.013). The observation of CBBB on the preoperative ECG was also an independent predictor of hemodynamic instability when the duration of the QRS interval was excluded from the model (OR=6.17; 95% CI, 1.3-27.7; *P*=.017).

DISCUSSION

This study shows that the duration of the QRS interval on the preoperative ECG is associated with a higher risk of hemodynamic instability during the immediate postoperative period in coronary revascularization surgery.

The prognostic value of the QRS interval in patients with heart failure or myocardial infarction and ventricular systolic dysfunction is well known.[1-5] However, the possible prognostic role of the QRS interval on the preoperative ECG has scarcely been explored in coronary surgery. In 2006, Acil et al[18] studied the predictive value of a prolonged QRS interval in the development of postoperative low cardiac output syndrome, but only in patients with preoperative left ventricular systolic dysfunction who underwent revascularization with CPB. In our patients, the systolic function was predominantly preserved (over 40% in 86% of the study group),

TABLE 2. **Clinical Characteristics Associated With the Onset of Hemodynamic Instability**

Variable (n=203)	Hemodynamic Instability		*P*
	Yes (46%)	No (54%)	
Width baseline QRS, ms	92.5 (80-120)	80 (80-98)	.001
Baseline bundle branch block, n	22 (23)	10 (9)	.006
Peripheral arterial disease, n	9 (27)	7 (13)	.093
Preoperative CHF, n	15 (16)	9 (8)	.095
Use of CPB, n	64 (68)	57 (52)	.022
Use of arterial graft, n	23 (68)	48 (86)	.042
Grafts/patient, n	2 (2-3)	2 (2-3)	.077
Myocardial ischemic time, mean (SD), min	36.3 (29.8)	23.2 (30.8)	.008
CPB time, mean (SD), min	78 (48.7)	48.3 (50.1)	.001

CHF indicates congestive heart failure; CPB, cardiopulmonary bypass; SD, standard deviation.

TABLE 3. **Logistic Regression Multivariate Analysis of the Onset of Hemodynamic Instability During the Early Postoperative Period**

Variables	Univariate		Multivariate[a]	
	P	OR (95% CI)	*P*	OR (95% CI)
QRS width, 10 ms	.001	1.26 (1.10-1.42)	.007	1.49 (1.11-2.00)
Without arterial graft	.042	2.87 (1.016-8.13)	.029	3.60 (1.14-11.62)
CPB time, min	.001	1.013 (1.006-1.020)	.013	1.013 (1.003-1.023)
Myocardial ischemic time, min	.008	1.014 (1.003-1.025)	.702	–
Use of CPB	.022	1.94 (1.09-3.46)	.809	–
Preoperative	.095	1.86 (0.372-9.345)	.273	–
Peripheral arterial disease	.093	1.89 (0.456-7.812)	.146	–
Grafts/patient, n	.077	1.15 (0.408-6.369)	.644	–

CHF indicates congestive heart failure; CI, confidence interval; CPB, cardiopulmonary bypass; OR, odds ratio.
[a]Adjusted for age, sex, center, number of diseased vessels, history of previous atrial fibrillation and systolic dysfunction (left ventricular ejection fraction <40%).

which indicates that the QRS duration may be a risk marker in this population as well. On the other hand, the QRS interval maintained its significance after adjustment for the use of CPB, a fact indicates that its prognostic value is independent of the latter. In 2000, Abdelnoor et al[19] related a longer duration of the preoperative QRS complex in coronary patients to a higher risk of experiencing cardiac arrest during the immediate postoperative period. In 2005 Biffi et al[20] related the longer duration of the preoperative QRS interval to death and heart failure over the long term. In our report, the low number of events does not enable us to relate the QRS interval to mortality, but it does show that there is a higher incidence of hemodynamic instability during the immediate postoperative period.

There could be several mechanisms to explain the association between preoperative QRS and a poorer postoperative prognosis in coronary surgery. It could be that it actually masks a greater burden of ischemic myocardial disease and risk factors in these patients.[23,24] Our results indicate an association with more severe coronary disease, since a longer duration of the preoperative QRS interval is associated with a larger number of diseased coronary vessels, a higher number of grafts per patient and longer myocardial ischemic and CPB times. The fact that the patients with CBBB on the preoperative ECG more often underwent CPB during the operation appears to strengthen this association.

On the other hand, it could also be that the prolongation of the QRS interval is associated with changes in the function and structure of left ventricle.[25-27] In our study, although we did not observe an inverse relationship between the QRS duration and the LVEF, the QRS interval was longer in patients with impaired systolic function (LVEF under 40%). One important aspect is the fact that the preoperative LVEF is not associated with a higher risk for hemodynamic instability, but QRS duration is, regardless of the degree of ventricular dysfunction. It could be that a more prolonged QRS interval would indicate an early and subtle deterioration of the myocardium, too soon to show an impact on the LVEF, but with a reduced contractile or hemodynamic reserve. On the other hand, there may

be a higher prevalence of ventricular mechanical dyssynchrony in these patients, which leads to a decrease in myocardial efficiency.[28-30] Probably all these pathophysiological mechanisms contribute to the association between the QRS interval and hemodynamic instability during the postoperative period.

It is interesting that this association between the QRS interval and hemodynamic instability occurred in the presence of a relatively preserved intraventricular conduction; 84% of the patients had a QRS interval of less than 120 milliseconds. This fact indicates a direct and continuous relationship between QRS duration and hemodynamic instability and that, in cases of acute stress, such as myocardial revascularization surgery, minor delays in intraventricular conduction can suffice to lead to a higher risk. Another interesting finding was the association between the QRS interval and a higher prevalence of previous paroxysmal atrial fibrillation and a higher incidence during the postoperative period. This could indicate that changes in ventricular conduction somehow have an impact on atrial conduction, a circumstance that, together with an increase in filling pressures, could enhance the risk of postoperative atrial fibrillation.

In our analysis, a longer CPB time and the absence of arterial grafts in the myocardial revascularization were also found to be independent predictors of hemodynamic instability. Several classical studies have emphasized the short-term and long-term benefits of arterial revascularization in coronary surgery, especially the use of LIMA,[31-33] as well as the negative effects on the prognosis of a prolonged CPB time.[33,34]

This study indicates that an inexpensive and simple method such as preoperative ECG, measuring the QRS interval, can provide important prognostic information. The current mortality risk models, EuroSCORE[35] and Parsonnet,[36] do not include any electrocardiographic variables. However, the QRS duration could be useful in the development of new models of surgical risk in patients undergoing myocardial revascularization surgery. Additional studies with larger populations will be necessary to define the prognostic role of this variable.

Limitations

From our findings, we can only infer that there is an association between a longer duration of the QRS interval on the preoperative ECG and a poorer postoperative course; however, although the longer QRS duration is simply a marker and not a cause of the poorer postoperative course, given the widespread availability of ECG and its routine use in any hospital, it would make financial sense to employ this variable as an indicator of risk. In our study, echocardiographic measurements of ventricular and interventricular dyssynchrony were not obtained, but might have provided additional information on the mechanisms involved. These measurements should be included in future studies in this field.

CONCLUSIONS

The prolongation of the QRS interval on the preoperative ECG predicts a higher risk of hemodynamic instability during the early postoperative period in patients who undergo coronary revascularization surgery.

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