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FUNCTIONAL PARAMETERS OF BLOOD CIRCULATION IN PATIENTS DURING FIRST SIX MONTHS OF RIGHT VENTRICULAR PACING IN QTc INTERVAL DURATION CLASSES

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37 patients (22 men and 15 women) with implanted pacemakers (PM) in DDD/DDDR and VVI/VVIR modes were investigated. Systolic blood pressure (SBP) and diastolic blood pressure, QTc interval duration, QRS complex duration, heart rate, end-systolic and end-diastolic volume, left ventricular ejection fraction, the thickness of the posterior wall of the left ventricle and interventricular septum, left ventricular myocardial mass, anterior-posterior size of the left atrium, right atrium and right ventricular were evaluated before, during acute postoperative period (3-5 days) and six months after pacemaker implantation. Patients were divided into classes 1 (normal QTc (320-440 ms)) - 17 (46 %) of the patients) and class 2 (long QTc (> 440 ms)) - 20 (54 %) patients) of QTc interval duration. For data processing were used standard statistical procedures by Microsoft Excel. PM implantation, increasing to a greater extent initially normal and less - an elongated QTc interval duration, to 6 months period leads them to the same level of values in both QTc interval duration classes. Increase of SBP and QRS complex duration in the class 2 demonstrates the need for more intensive monitoring and drug management in these patients.

KEY WORDS: cardiac pacing, right ventricular pacing, electrocardiography, QTc interval, echocardiography

КЛАС ТРИВАЛОСТІ ІНТЕРВАЛУ QTc І ФУНКЦІОНАЛЬНІ ПОКАЗНИКИ КРОВООБИГУ У ПАЦІЄНТІВ З ПРАВОШЛУНОЧКОВОЮ СТИМУЛЯЦІЄЮ У ПЕРШІ ПІВРОКУ ПІСЛЯ ІМПЛАНТАЦІЇ ЕКС

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Обстежені 37 пацієнтів (22 чоловіки та 15 жінок) з імплантованими одно- і двокамерними електрокардіостимуляторами (ЕКС) в режимах DDD/DDDR і VVI/VVIR. Оцінювали до, в гострому післяопераційному періоді (3-5 добу) і через півроку після імплантації ЕКС рівень систолічного артеріального тиску (САТ) і діастолічного артеріального тиску, тривалість інтервалу QTc, комплексу QRS, частоту серцевих скорочень; кінцево-сistolічний і кінцево-дістолічного об'єму, фракцію викиду лівого шлуночка, товщину задньої стінки лівого шлуночка і міжшлуночкової перегородки, масу міокарда лівого шлуночка, передньо-задній розмір лівого передсердя, правого передсердя і правого шлуночка. Пацієнти були розділені на класи 1 (нормального QTc (320-440 мс)) - 17 (46 %) пацієнтів) і 2 (подовженого QTc (> 440 мс)) - 20 (54 %) пацієнтів) тривалості інтервалу QTc. Для обробки даних використовувалися стандартні статистичні процедури за допомогою Microsoft Excel. Імплантація ЕКС, збільшуючи більшою мірою початково нормальну і в меншій - подовжену тривалість інтервалу QTc, приводила її до піврічного періоду до одного рівня значень в обох класах тривалості інтервалу QTc. Збільшення САТ і тривалості комплексу QRS в класі 2 свідчить про необхідність більш інтенсивного спостереження та медикаментозного менеджменту у цих пацієнтів.

КЛЮЧОВІ СЛОВА: електрокардіостимуляція, правошлуночкова стимуляція, електрокардіографія, інтервал QTc, ехокардіографія

КЛАСС ПРОДОЛЖИТЕЛЬНОСТИ ИНТЕРВАЛА QTc И ФУНКЦИОНАЛЬНЫЕ ПОКАЗАТЕЛИ КРОВООБРАЩЕНИЯ У ПАЦИЕНТОВ С ПРАВОЖЕЛУДОЧКОВОЙ СТИМУЛЯЦИЕЙ В ПЕРВЫЕ ПОЛГОДА ПОСЛЕ ИМПЛАНТАЦИИ ЭКС

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Обследованы 37 пациентов (22 мужчины и 15 женщин) с имплантированными одно- и двухкамерными электрокардиостимуляторами (ЭКС) в режимах DDD/DDDR и VVI/VVIR. Оценивали до, в остром послеоперационном периоде (3-5 сутки) и через полгода после имплантации ЭКС уровень систолического артериального давления (САД) и диастолического артериального давления, продолжительность интервала QTc, комплекса QRS, частоту сердечных сокращений; конечно-систолический и конечно-диастолический объемы, фракцию выброса левого желудочка, толщину задней стенки левого желудочка и межжелудочковой перегородки, массу миокарда левого желудочка, передне-задний размер левого предсердия, правого предсердия и правого желудочка. Пациенты были разделены на классы 1 (нормального QTc (320-440 мс)) - 17 (46 %) пациентов) и 2 (удлиненного QTc (> 440 мс)) - 20 (54 %) пациентов) продолжительности интервала QTc. Для обработки данных использовались стандартные статистические процедуры с помощью Microsoft Excel. Имплантация ЭКС, увеличивая в большей степени исходно нормальную и в меньшей - удлиненную продолжительность интервала QTc, приводила ее в полугодием периоде к одному уровню значений в обоих классах продолжительности интервала QTc. Увеличение САД и продолжительности комплекса QRS в классе 2 свидетельствует о необходимости более интенсивного наблюдения и медикаментозного менеджмента у этих пациентов.

КЛЮЧЕВЫЕ СЛОВА: электрокардиостимуляция, правожелудочковая стимуляция, электрокардиография, интервал QTc, эхокардиография

INTRODUCTION

Right ventricular (RV) pacing is one of the leading treatment methods for bradyarrhythmias [1]. Blood circulation functional parameters monitoring allows control the pacemaker and accompanying medical treatment [1-3].

Output of corrected QT interval duration (QTc) values beyond physiological scope is a poor prognostic sign, not only in patients with spontaneous rhythm, but also with the pacemaker (PM) [4]. Despite this, functional parameters of blood circulation in QTc interval duration classes of stimulated complexes in patients with PM have not previously been studied.

OBJECTIVE

The purpose of this study is to evaluate functional parameters of blood circulation in patients during first six months of right ventricular pacing in QTc interval duration classes.

MATERIALS AND METHODS

37 patients aged 68 ± 9 (M \pm sd) (15 - female, 22 - male) were examined in the department of ultrasound and instrumental diag-

nostics with miniinvasive interventions of GI «Zaycev V.T. Institute of General and Urgent Surgery of NAMS of Ukraine», among them - 9 patients have atrial fibrillation (AF). All patients were underwent permanent pacing therapy from 2006 to 2013 in modes: DDD (8 patients) and DDR (14 patients), VVI (8 patients), VVIR (7 patients). RV pacing more than 50 % was observed in 35 (78 %) patients. Mainly atrial pacing (AP) (90 %) during DDD/DDDR pacing was observed in 8 patients (18 %) with sick sinus node syndrome (SSNS).

Functional parameters of blood circulation were evaluated before, in acute postoperative period (3-5 hours) and six months after PM implantation: systolic blood pressure (SBP) and diastolic blood pressure (DBP); ECG parameters: QTc interval duration, QRS complex duration, heart rate (HR); echocardiography (EchoCG) parameters: end-systolic volume (ESV) and end-diastolic volume (EDV), ejection fraction (EF) of the left ventricle (LV), the thickness of the left ventricle posterior wall (LVPW), the thickness of the interventricular septum (IVS) left ventricular myocardial mass (LVMM), antero-posterior dimension of the left atrium (LA), right atrium (RA) and right ventricular (RV).

To measure the duration of the QT interval and heart rate of the patients before and after pacemaker implantation (3-5 days after surgery) were recorded on a computer ECG electrocardiograph «Cardiolab +» (HAI-Medica). The stimulated QTc interval duration was measured after the removal of the stimulus artifact in three consecutive complexes of the Q wave to the beginning of the descending segment of the return of the T wave in leads to the contour II, V5, and V6 with choosing of a maximum value. The corrected QT interval duration (QTc) of the patients with spontaneous rhythm and pacing was calculated by the Bazett formula: $QTc = QT / (RR \wedge 0,5)$. For patients with AF, QTc was calculated using the formula $QTc = QT + 0,154 \times (1000 - RR)$ Fermingem study for patients with atrial fibrillation [5], the measurement accuracy - 0.5 ms.

Echocardiography was conducted by the ultrasound machine Siemens Cypress and Toshiba Applio 400. RA, LA, RV sizes, end-systolic size (ESS), end-diastolic size (EDS) and LVPW, IVS thickness was measured. EDV and ESV were calculated by the method of Simpson. Left ventricular mass (LVM) was calculated according to the formula Devereux: $LVM = 1.04 * ((AP \text{ LV} + IVS + ESS)^3 - ESS^3) - 13.6$ [6]. The measurement accuracy was 0.5 mm. For the calculation of EF using the formula $EF = SV / EDV$ (SV-stroke volume) [6]. SBP and DBP were measured by tonometer Microlife BP AG1-20 by Korotkov method, the measurement accuracy - 1 mm Hg.

The patients with pacemakers were divided into 3 classes of QTc interval duration of

stimulated complexes (further classes): Class 1 - normal (in the physiological range of values) - 320-439 ms, Class 2 - (qualified) an elongated QTc interval- > 440 ms, and Class 3 - (qualified) shortened QTc interval - < 320 ms [7].

There are a 17 (46 %) patients aged 65 ± 11 in class 1 (male - 9 female - 8, in the stimulation mode DDD/DDDR - 9 patients (53 %), VVI/VVIR - 8 patients (47 %)) and 20 (54 %) patients aged 71 ± 8 in class 2 (male - 13 female - 7, in the stimulation mode DDD/DDDR - 13 patients (65 %), VVI/VVIR - 7 patients (35 %)). In class 3, there was not a single patient. Values were estimated in the classes of QTc interval duration in groups of DDD/DDDR and VVI/VVIR stimulation modes.

The data were processed after formation the Microsoft Excel and Statistica base. For statistical evaluation of the results, the parametric criteria (mean - M, standard deviation - sd) and nonparametric ones (absolute (n, number) and relative (percentage of (p, %) and the criterion χ^2) units) were used. The probability of differences between groups was determined using a non-parametric U - Mann-Whitney test. The expected result is determined by levels of reliability $p < 0.01$ and $p < 0.05$.

RESULTS AND DISCUSSION

QTc interval duration during first six months of right ventricular pacing in different modes of stimulation in classes 1 and 2 is shown in fig. 1.

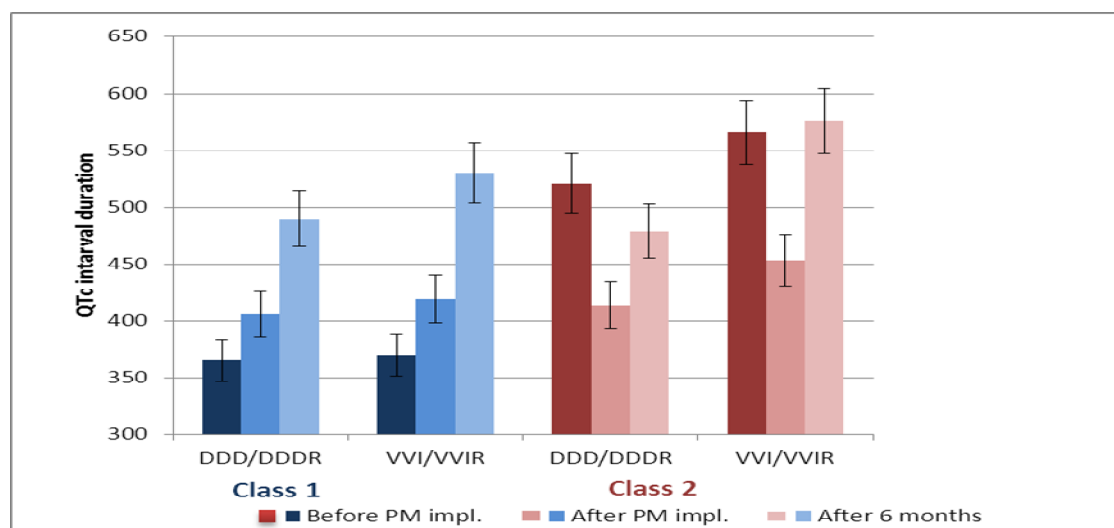


Fig. 1. QTc interval duration during first six months of right ventricular pacing in different modes of stimulation in classes 1 and 2.

In class 1 the QTc interval duration after PM implantation naturally increased, peaking to half-year period of observation in both DDD/DDDR, and in VVI/VVIR modes. The degree of QTc interval duration increase was greater in the VVI/VVIR mode than in the DDD/DDDR mode. In class 2 after almost twofold reduction in the acute postoperative period after PM implantation it increased again

six months later, approaching the value set before the operation. The degree of this increase was greater in the VVI/VVIR mode of than in the DDD/DDDR mode.

Functional parameters blood circulations in patients with right ventricular pacing in different modes in first six months after pacemaker implantation in QTc interval duration classes are shown in tab. 1.

Table 1

Functional parameters blood circulations in patients with right ventricular pacing in different modes in first six months after pacemaker implantation in QTc interval duration classes

Functional parameters		Pacing mode	QTc interval duration					
			Normal			Elongated		
			Before PM	After PM implantation (3-5 months)	After 6 months	Before PM	After PM implantation (3-5 months)	After 6 months
Arterial pressure (M±sd, mm Hg)	SBP	DDD/DDDR	130±18	125±8	122±11	146±17*	124±12	140±19*
		VVI/VVIR	143±15	130±6	134±9	142±17*	130±11	149±12*
	DBP	DDD/DDDR	79±12	79±5	75±7	84±10	86±7	90±11
		VVI/VVIR	84±9	84±5	82±8	81±9	82±6	82±7
ECG parameters	QRS (M±sd, ms)	DDD/DDDR	90±15	118±27	126±21**	115±27	141±24*,**	148±30*,**
		VVI/VVIR	102±21	132±20	149±22**	124±28	138±21	159±37
	HR (M±sd, 1/min)	DDD/DDDR	48±15	67±6	66±8	54±14	71±10	68±11
		VVI/VVIR	53±8	65±7	62±8	62±17	72±7	70±12
EchoCG parameters	ESV (M±sd, ml)	DDD/DDDR	77±34**	40±23	48±19	94±52**	61±41	79±38
		VVI/VVIR	66±25	48±18	51±15	75±43	77±36	76±29
	EDV (M±sd, ml)	DDD/DDDR	188±34**	159±29	160±31	175±55	146±49	154±48
		VVI/VVIR	139±32	132±28	140±33	195±49*,**	151±43	164±40
	EF (M±sd, %)	DDD/DDDR	52±7	53±6	50±8	52±12	54±10	51±12
		VVI/VVIR	54±9	56±7	50±11	53±13	54±10	50±9
	LVPW (M±sd, sm)	DDD/DDDR	1±0,1	1±0,1	1±0,1	1±0,1	1±0,1	1±0,1
		VVI/VVIR	1±0,1	1±0,1	1±0,2	1±0,2	1±0,1	1±0,1
	IVS (M±sd, sm)	DDD/DDDR	1±0,2	1±0,1	1±0,1	1±0,2	1±0,1	1±0,1
		VVI/VVIR	1±0,1	1±0,1	1±0,2	1±0,2	1±0,2	1±0,2
	LVMM (M±sd, g)	DDD/DDDR	369±81	369±81	371±72	319±77	320±77	351±65
		VVI/VVIR	320±64	317±61	330±47	331±90	326±86	390±79
	LA (M±sd, sm)	DDD/DDDR	4±0,4	4±0,5	4±0,4	4±0,7	4±0,6	4±0,5
		VVI/VVIR	4±0,5	4±0,5	4±0,5	4±0,7	4±0,6	4±0,6
	RA (M±sd, sm)	DDD/DDDR	5±0,5	5±0,4	4,9±0,5	4±0,4	4±0,4	4±0,4
		VVI/VVIR	4±0,4	4±0,4	4,3±0,5	5±0,5	5±0,6	5,2±0,6
RV (M±sd, sm)	DDD/DDDR	5±0,6	5±0,6	5±0,5	5±0,6	5±0,6	5±0,6	
	VVI/VVIR	4±0,5	4±0,4	4,5±0,5	5±0,7	5±0,6	5,2±0,6	

Notes:

* p < 0,05 – between values in classes;

** p < 0,05 – between values in class before and after PM implantation

SBP in class 1 was not significantly changed with pacemaker implantation in both DDD/DDDR and VVI/VVIR modes, and in the class 2 it decreased in acute postoperative period, returning after six months to baseline values. The degree of increase was greater in the VVI/VVIR mode, than in the DDD/DDDR mode. Pacemaker implantation had no effect on DBP in classes 1 and 2 in both modes of stimulation.

The duration of the QRS complex in class 1 did not change with pacemaker implantation in the acute postoperative period, but significantly increased after six months in both modes of stimulation. The degree of increase was greater in the VVI/VVIR mode. In class 2 the duration of QRS complex increased in the acute postoperative period and remained so six months after pacemaker implantation. Increase was observed only in the DDD/DDDR. Changes in HR after pacemaker implantation in classes 1 and 2 of QTc interval duration in both modes of stimulation was not observed.

ESV and EDV in class 1 of QTc interval duration decreased with pacemaker implantation in acute postoperative period only in the DDD/DDDR mode and did not change significantly after six months in both modes of stimulation. In class 2 reduction ESV with pacemaker implantation was observed in the DDD/DDDR mode, and EDV - both in the DDD/DDDR and in the VVI/VVIR modes. Six months later, CSR and CSR changes were observed in both modes of stimulation.

PM implantation had no effect on EF, thickness of IVS, LVPW, antero-posterior dimension of RA, LA, RV in DDD/DDDR and VVI/VVIR modes in classes of QTc interval duration.

QTc interval prolongation during RV stimulation, which we found six months after PM implantation, corresponds to the data [8, 9] for its initially normal and the data [10, 11] - an extended duration.

In contrast to [12], who showed no reaction SBP and DBP in patients after PM implantation, we received an increase of SBP in the class of increased QTc interval duration, which can be associated both with increased duration of electrical systole and insufficient antihypertensive therapy in this class.

QRS complex prolongation in the class of increased QTc interval duration, which we found in patients with DDD/DDDR and

VVI/VVIR cardiac pacing, differed from the data [13, 14] described it only in patients with biventricular stimulation and has not been studied in the classes of the QTc interval duration.

In contrast to the data [15], showed a decrease of ESV and EDV only in patients with biventricular PM, we discovered it in DDD/DDDR and VVI/VVIR modes of cardiac pacing, which can be explained more physiological impulse conduction due to the right ventricular electrode implantation in interventricular septum in our study, against its implantation in apex. Reduction of ESV and EDV happened is statistically significant changes in the PV modes DDD / DDDR and VVI / VVIR pacemaker, which corresponds to the data [9, 15].

Changes in functional parameters of blood circulation in patients in the first six months of right ventricular pacing after PM implantation are determined in generally, among other factors, by QTc interval duration class. There more often changes in patients with prolonged QTc interval duration indicate that they require more intensive PM monitoring and therapeutic management, in particular strengthening of antihypertensive therapy.

CONCLUSIONS

1. DDD/DDDR and VVI/VVIR pacemaker implantation, increasing to a greater extent initially normal and less - an elongated QTc interval duration, to 6 months period leads them to the same level of values in both QTc interval duration classes.

2. Increased QTc interval duration associated with higher SBP and longer QRS complex duration in DDD/DDDR mode, normal - with greater reduction ESV and EDV in DDD/DDDR and VVI/VVIR modes.

3. Patients with increased QTc interval duration after right ventricular PM implantation require more intensive monitoring and enhancing medication.

PROSPECTS FOR FUTURE STUDIES

It seems appropriate to investigate the relationship between QTc interval duration after right ventricular PM implantation and changes in functional parameters of blood circulation after correction of drug therapy in the class of prolonged QTc interval duration in late postoperative period.

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