

FUNCTIONAL BLOOD CIRCULATION VALUES IN PATIENTS WITH IMPLANTED PACEMAKERS AND CARDIAC RESYNCHRONIZATION THERAPY AFTER YEAR OF PERMANENT PACING IN DIFFERENT QRS COMPLEX DURATION CLASSES

Shanina I. V.

V. N. Karazin Kharkiv National University, Kharkiv, Ukraine

Functional blood circulation values were prospectively investigated in 100 patients (46 – women, 54 – men) with permanent pacemakers and in 29 patients (10 – women, 19 – men) – with cardiac resynchronization therapy (CRT) with mean age 69 ± 7 years in different observation stages taking into account QRS complex duration classes (class 1 – under 120 ms (normal), 2 – 120-149 ms (long) and 3 – more than 150 ms (significantly elongated)). Medication support was included beta-blockers; amiodarone; renin-angiotensin-aldosterone system inhibitors: angiotensin converting enzyme and angiotensin II inhibitors; antithrombotic agents; oral anticoagulants; statins and diuretics. Ventricular rate of spontaneous and stimulated rhythm; systolic and diastolic blood pressure; ejection fraction, end-diastolic and end-systolic volumes of the left ventricle; interventricular septum thickness and left ventricular posterior wall, right atria and ventricle sizes were evaluated. The results showed that QRS complex widening associated with greater deviation of functional blood circulation values from physiological norms. Permanent pacing with medical support had no significant impact on the functional blood circulation values, and CRT contributed reverse remodeling higher in class 3 of QRS complex duration. Also it was concluded that there is a necessity of medical support improvement.

KEY WORDS: permanent pacing, chronic heart failure, QRS complex duration

ФУНКЦІОНАЛЬНІ ПОКАЗНИКИ КРОВООБІГУ У ПАЦІЄНТІВ З ЕЛЕКТРОКАРДІОСТИМУЛЯТОРАМИ І КАРДІОРЕСІНХРОНІЗУЮЧОЮ ТЕРАПІЄЮ ЧЕРЕЗ РІК ПОСТІЙНОЇ ЕКС У РІЗНИХ КЛАСАХ ТРИВАЛОСТІ QRS

Шаніна І. В.

Харківський національний університет імені В. Н. Каразіна, м. Харків, Україна

Проспективно були вивчені функціональні показники кровообігу (ФПК) у 100 (46 – жінок, 54 – чоловіків) пацієнтів з електрокардіостимуляторами (ЕКС) і у 29 (10 – жінок, 19 – чоловіків) – з кардіоресінхронізуючою терапією (КРТ) у віці 69 ± 7 років з імплантованими електрокардіостимуляторами (ЕКС) на річних етапах спостереження з урахуванням класів (1 клас – до 120 мс (нормальний), 2 – 120-149 мс (подовжений) і більше 150 мс (істотно подовжений)) тривалості QRS комплексу. Медикаментозний супровід включав бета-блокатори; аміодарон; інгібітори ренін-ангіотензин-альдостеронової системи: АПФ і рецепторів ангіотензину II; антитромботичні засоби; пероральні антикоагулянти; статини і діуретики. Оцінювали частоту шлуночкових скорочень спонтанного та стимульованого ритму, тривалість QRS комплексу; рівні систолічного і діастолічного артеріального тиску; фракцію викиду, кінцево-діастолічний і кінцево-систолічний об'єми лівого шлуночка; товщину міжшлуночкової перегородки і задньої стінки лівого шлуночка, розміри передсердь і правого шлуночка. Результати показали, що чим більше клас тривалості QRS комплексу, тим більше ухилення ФПК від фізіологічних нормативів. Ступінь їх сильніше при КРТ, ніж ЕКС. ЕКС з медикаментозною підтримкою не вплинула суттєво на ФПК, і КРТ сприяла їх зворотного ремодельованню, більшого в класі 3 тривалості QRS комплексу. Робляться висновки про необхідність посилення медикаментозної підтримки.

КЛЮЧОВІ СЛОВА: постійна електрокардіостимуляція, хронічна серцева недостатність, тривалість QRS комплексу

ФУНКЦИОНАЛЬНЫЕ ПОКАЗАТЕЛИ КРОВООБРАЩЕНИЯ У ПАЦИЕНТОВ С ИМПЛАНТИРОВАННЫМИ ЭЛЕКТРОКАРДИОСТИМУЛЯТОРАМИ И КАРДИОРЕСИНХРОНИЗИРУЮЩЕЙ ТЕРАПИЕЙ ЧЕРЕЗ ГОД ПОСТОЯННОЙ ЭКС В РАЗНЫХ КЛАССАХ ПРОДОЛЖИТЕЛЬНОСТИ QRS

Шанина И. В.

Харьковский национальный университет имени В. Н. Каразина, г. Харьков, Украина

Перспективно были изучены функциональные показатели кровообращения (ФПК) у 100 (46 – женщин, 54 – мужчин) пациентов с имплантированными электрокардиостимуляторами (ЭКС) и у 29 (10 – женщин, 19 – мужчин) – с кардиоресинхронизирующей терапией (КРТ) в возрасте 69 ± 7 лет с имплантированными электрокардиостимуляторами (ЭКС) на годовом этапе с учетом классов (класс 1 – до 120 мс (нормальный), 2 – 120-149 мс (удлиненный) и более 150 мс (существенно удлиненный)) продолжительности QRS комплекса. Медикаментозное сопровождение включало бета-блокаторы; амиодарон; ингибиторы ренин-ангиотензин-альдостероновой системы; ангиотензинпревращающего фермента и рецепторов ангиотензина II; антитромботические средства; пероральные антикоагулянты; статины и диуретики. Оценивали частоту желудочковых сокращений спонтанного и стимулированного ритма; уровни систолического и диастолического артериального давления; фракцию выброса, конечно-диастолический и конечно-систолический объемы левого желудочка; толщину межжелудочковой перегородки и задней стенки левого желудочка, размеры предсердий и правого желудочка. Результаты показали, что чем больше класс продолжительности QRS комплекса, тем больше уклонения ФПК от физиологических нормативов. Степень их сильнее при КРТ, чем ЭКС. ЭКС с медикаментозной поддержкой не повлияла существенно на ФПК, и КРТ способствовала их обратному ремоделированию, большему в классе 3 продолжительности QRS комплекса. Делаются выводы о необходимости усиления медикаментозной поддержки.

КЛЮЧЕВЫЕ СЛОВА: постоянная электрокардиостимуляция, хроническая сердечная недостаточность, продолжительность QRS комплекса

INTRODUCTION

Permanent pacemaker implantation and cardiac resynchronization therapy (CRT) become one of the standards of skilled cardiac care nowadays, what is confirmed by an international roster of implantable devices EHRA White Book [1].

Increased frequency pacemaker implantation leads to a progressive increase in the number of persons in need, not only in monitoring effectiveness of this way of therapy, but also accompanied by adequate therapeutic management [2].

QRS complex duration relationship and functional circulation values changes in patients with permanent pacemaker and CRT in long-term observations were not wide studied [3-5].

OBJECTIVE

The purpose of the study – to assess functional blood circulation values in patients with implanted pacemaker and CRT at the annual stage taking into account QRS complex duration classes.

MATERIALS AND METHODS

100 patients (46 – women, 54 – men) with implanted pacemaker and 29 patients (10 – women, 19 – men) with CRT were examined in the department of ultrasound and clinical-instrumental diagnosis and minimally invasive interventions of SI «Zaytsev V.T. Institute of General and Emergency Surgery NAMS of Ukraine». Mean age was 69 ± 7 years. The indications for pacemaker implantation were atrio-ventricular block of various degrees (AV block) – 66 patients (60 %), sinus sick syndrome (SSS) – 34 patients (40 %). Single chamber (VVI – 40 devices) and double chamber devices (DDD – 60 devices) were implanted. The indications for CRT were chronic heart failure (CHF) NYHA functional class (FC) II-IV, QRS complex duration more than 120 ms, left ventricular ejection fraction (LVEF) ≤ 35 %. CRT-P and CRT-D devices were implanted.

Spontaneous and induced rhythm ventricular contractions, systolic (SBP) and diastolic blood pressure (DBP), left ventricular ejection fraction (LVEF), end-diastolic (EDV) and end-systolic (ESV) volumes, interven-

tricular septum (IVS), posterior wall (PW) thicknesses, left (LA) and right atriums (RA), right ventricular (RV) sizes were evaluated before, in the early postoperative period (the third - fifth day), after 6 months and one year after pacemaker implantation.

SBP and DBP were measured by Korotkov's method according to the recommendations of the Association of Cardiologists of Ukraine for the prevention and treatment of hypertension by tonometer Microlife BP AG1 - 20 in clinostaze after 5 minutes rest. The measurement accuracy was 2 mm Hg.

Electrocardiogram (ECG) was performed on a computer electrocardiograph Cardiolab +2000. The stimulated QRS complex duration was measured in leads II, V5, V6 (the average of three consecutive complexes) with a choice of maximum value. Measurement accuracy proved to be 1 ms.

Patients were divided to three QRS complex duration classes in accordance with Haghjoo M. et al: 1 – under 120 ms (normal), 2 – 120-149 ms (extended) and more than 150 ms (significantly extended). Functional blood circulation values were defined in selected classes.

Echocardiography study was conducted on the ultrasound machine Toshiba Applio 400. LF, RF, RV sizes and IVS, PW thickness was measured. To calculate the EDV and ESV used method of Simpson. LV EF was calculated using the formula $EF = (EDV - ESV) / EDV * 100 \%$.

Medication support was carried with antiarrhythmic drugs (beta-blockers and amiodarone)), renin-angiotensin- aldosterone inhibitors (RAAI) (angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor antagonists II (ARA II)), anti-thrombotic drugs (antiplatelet agents (acetylsalicylic acid (ASA)), oral anticoagulants (AC) (warfarin/dabigatran), statins, and diuretics.

The data were brought into the Microsoft Excel base. For statistical evaluation of the results were used the parametric criteria (the mean – M, the standard deviation – sd). Comparing of QRS duration complex classes on the observation stages was conducted on each separate functional blood circulation value using a non-parametric U-Mann-Whitney test. Probable results were determined at levels of reliability $P < 0.05$.

RESULTS AND DISCUSSION

Comparative characteristics of functional blood circulation values in patients in different QRS complex duration classes before implantation, in the early postoperative period, 6 months and a year later after permanent pacemaker implantation are presented in table 1 and in CRT patients – in table 2.

In patients with permanent pacemakers in all QRS complex duration classes VC initially was below the physiological norm, and after the pacemaker implantation went to the physiological level ($p < 0.05$), which remained the whole observation period. In patients with CRT VC did not leave the physiological range in all classes on the observation stages.

Patients with high baseline SBP pacemaker patients and decreased in step one year of observation reached physiological range in all classes QRS duration complex. In patients with MCT in classes 1 and 2 it was in the physiological range of values at all stages of observation, and grade 3 initially increased and decreased in the physiological range included in the early postoperative period. DBP at all stages of observation in all patients with a pacemaker and CRT were in the physiological range.

Pacemaker implantation did not affect the normal baseline CSR and MLC in classes 1, 2 and enlarged in class 3. In accordance with the EF also did not change. In patients with MCT by reducing the original magnification CSR and EDV increase occurred initially reduced LVEF in grades 2 and 3 of the complex QRS duration, 50 % and 87 %, respectively.

Pacemaker implantation and CMT in the selected classes QRS duration complex has not led to a significant decrease in the thickness of the IVS and PWLV.

Pacemaker implantation has not affected initially increased size of the LP on the stage of the annual observations, while the CMT contributed to its reduction in all classes QRS duration complex.

Dimensions RA and RV before and on the stages of pacemaker were normal. In patients with CMT initially increased size of the PP in the class 1 is not changed, the class 2 and 3 - Changes to decrease occurred in the period of the annual monitoring, more pronounced in the class 3 ($p \leq 0.05$). At baseline, the increased size of the prostate in class 1 is not changed, the class 2 and 3 - decreased.

Table 1

Functional blood circulation values in patients with permanent pacemaker on the different observation stages (M ± sd)

Functional values		QRS complex duration											
		Under 120 ms				120-149 ms				150 and more ms			
		Before	Early postoperative	6 months after	Year after	Before	Early postoperative	6 months after	Year after	Before	Early postoperative	6 months after	Year after
VC (1/min)		52 ± 11	68 ± 6*	64 ± 3	67 ± 8	46 ± 8	71 ± 11*	69 ± 7	67 ± 7	46 ± 9	68 ± 7*	70 ± 7	64 ± 8
Blood pressure (mm Hg)	SBP	150 ± 15	154 ± 17	140 ± 27	133 ± 13	140 ± 15	139 ± 16	124 ± 14	120 ± 8	153 ± 18	151 ± 19	144 ± 25	122 ± 22
	DBP	82 ± 6	89 ± 9	80 ± 7	78 ± 10	81 ± 9	83 ± 10	84 ± 9	82 ± 3	79 ± 7	87 ± 9	85 ± 17	80 ± 13
Echo values	LVEF (%)	53 ± 10	54 ± 11	65 ± 8	47 ± 8	47 ± 8	53 ± 8	50 ± 9	56 ± 7	50 ± 6	47 ± 8	55 ± 12	43 ± 16
	ESV (ml)	63 ± 28	59 ± 26	52 ± 11	65 ± 11	70 ± 31	58 ± 22	66 ± 19	67 ± 18	83 ± 35	81 ± 36	102 ± 64	124 ± 54
	EDV (ml)	135 ± 44	127 ± 29	148 ± 16	123 ± 18	133 ± 29	122 ± 24	132 ± 27	154 ± 23	166 ± 35	153 ± 48	227 ± 129	219 ± 142
	IVS (sm)	1.2 ± 0.1	1.2 ± 0.1	1.0 ± 0.2	1.0 ± 0.2	1.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1
	LVPW (sm)	0.9 ± 0.1	0.9 ± 0.1	1.2 ± 0.1	1.0 ± 0.2	1.0 ± 0.1	1.0 ± 0.1	1.0 ± 0.2	1.0 ± 0.1	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.2	1.2 ± 0.1
	LA (sm)	4.9 ± 0.6	4.8 ± 0.6	4.5 ± 0.5	4.7 ± 0.6	4.3 ± 0.5	4.3 ± 0.5	4.8 ± 0.6	3.9 ± 1.3	4.5 ± 0.5	4.5 ± 0.5	4.5 ± 0.5	4.5 ± 0.5
	RA (sm)	4.8 ± 1.0	4.8 ± 1.0	4.5 ± 1.0	4.5 ± 1.0	4.4 ± 0.5	4.4 ± 0.5	4.4 ± 0.5	4.1 ± 0.6	4.4 ± 0.5	4.3 ± 0.5	4.6 ± 0.6	4.7 ± 0.5
	RV (sm)	3.0 ± 0.4	3.0 ± 0.4	3.0 ± 0.4	3.0 ± 0.4	3.2 ± 0.6	3.2 ± 0.6	3.2 ± 0.7	3.8 ± 0.4	3.2 ± 0.6	3.2 ± 0.6	3.2 ± 0.9	3.5 ± 0.5

According to these functional blood circulation values there are significant differences (p < 0.05):

* – Before implantation and early postoperative observation stage;

** – Early postoperative and 6 months after implantation;

*** – 6 months and year after.

Table 2

Functional blood circulatory values in patients with CRT on the observation stages (M ± sd)

Functional blood circulatory values		QRS complex duration											
		Under 120 ms				120-149 ms				150 and more ms			
		Early postoperative	6 months after	Year after	Before	Early postoperative	6 months after	Year after	Before	Early postoperative	6 months after	Year after	
VC (1/min)		69 ± 9	70 ± 7	68 ± 7	72 ± 7	74 ± 19	68 ± 6	68 ± 2	69 ± 7	70 ± 7	76 ± 6	68 ± 5	
Blood pressure (mm Hg)	SBP	126 ± 15	122 ± 12	120 ± 12	137 ± 11	133 ± 18	120 ± 12	133 ± 5	148 ± 18	129 ± 8	126 ± 19	123 ± 8	
	DBP	79 ± 13	80 ± 7	80 ± 8	83 ± 4	80 ± 7	81 ± 5	83 ± 3	81 ± 4	81 ± 2	84 ± 11	80 ± 9	
Echo values	LVEF (%)	30 ± 18	35 ± 9	35 ± 7	26 ± 7	29 ± 9	32 ± 8	39 ± 5***	23 ± 4	29 ± 5*	34 ± 8	43 ± 9***	
	ESV (ml)	228 ± 160	226 ± 78	219 ± 66	300 ± 96	242 ± 63*	221 ± 68	173 ± 64	381 ± 89	262 ± 129*	229 ± 100	206 ± 89	
	EDV (ml)	324 ± 195	346 ± 18	336 ± 76	405 ± 94	340 ± 14*	326 ± 18	284 ± 81	497 ± 78	370 ± 80*	346 ± 128	359 ± 73	
	IVS (sm)	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.2	1.4 ± 0.1	1.4 ± 0.1	1.4 ± 0.1	1.3 ± 0.2	1.4 ± 0.1	1.4 ± 0.1	1.4 ± 0.1	1.4 ± 0.1	
	LVPW (sm)	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.2	1.3 ± 0.2	1.2 ± 0.2	1.2 ± 0.2	1.2 ± 0.2	1.3 ± 0.2	1.3 ± 0.2	1.3 ± 0.2	1.3 ± 0.2	
	LA (sm)	5.5 ± 0.5	5.4 ± 0.7	5.4 ± 0.7	5.4 ± 1.0	5.2 ± 1.0*	4.8 ± 1.0	4.8 ± 1.0	5.4 ± 1.0	5.2 ± 1.0*	5.2 ± 1.0	5.2 ± 1.0	
	RA (sm)	5.5 ± 0.5	5.5 ± 0.5	5.5 ± 0.5	6.0 ± 0.1	6.0 ± 0.1	5.9 ± 0.2	5.5 ± 0.4	6.0 ± 0.1	6.0 ± 0.1	5.1 ± 0.6	5.2 ± 0.8	
	RV (sm)	4.7 ± 0.3	4.5 ± 0.3	4.5 ± 0.3	3.5 ± 0.7	3.4 ± 0.7	3.2 ± 0.7	3.0 ± 1	3.6 ± 0.7	3.4 ± 0.7	3.2 ± 0.7	3.3 ± 0.7	

Our findings are broadly consistent with Molina L. et al. [6] showed less favorable in patients with longer QRS complex changes in functional parameters in a permanent pacemaker.

That we found in patients with a longer QRS complex after initiation of CMT trend towards greater improvement in functional parameters in general agreement with the data [7], as well as a multicenter randomized trial RAFT [8, 9], which included 1.483 patient with CMT.

It should be noted that the data on the changes in DBP and SBP in patients with permanent pacemaker and MCT have been studied previously.

CONCLUSIONS

1. The more complex QRS duration, the greater the deviation from the functional parameters of the circulatory physiological standards, the extent of which is stronger in patients undergoing CRT versus patients with permanent pacemaker.

2. On the one-year period of observation ECS with medical support no significant effect on the functional performance of circulation, with the exception of SBP, whereas MCT contributes to their reverse remodeling, the extent of which is greater, the higher the initial duration of the QRS complex.

3. Partial normalization of functional parameters of blood circulation in the class 3 patients with pacemaker and trend improvement in patients with CMT, the degree of which the lower, less complex QRS duration indicates not just necessary, but strengthening medical support.

PROSPECTS FOR FUTURE STUDIES

It seems appropriate further study this group of patients to assess the long-term changes of functional blood circulation values in different QRS complex duration classes.

REFERENCES

1. Auricchio A. The current status of cardiac electrophysiology in ESC members countries / A. Auricchio, K. H. Huck, R. Hatala et al. // 2014 White Book of EHRA. – 2014. – Vol. 7. – P. 509–518.
2. Brignole M. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy / M. Brignole, A. Auricchio, G. Baron-Esquivias et al. // European Heart Journal. – 2013. – P. 23–28.
3. Shanina I.V. Blood circulation values in patients with cardiac resynchronization therapy during the first 6 months in different stimulated QRS complex duration classes / I.V. Shanina, D.E. Volkov, N.I. Yabluchansky et al. // Украинский медицинский журнал. – № 4 (102). – 2014. С. 91–93.
4. Stavrakis S. The Benefit of Cardiac Resynchronization Therapy and QRS Duration: A Meta-Analysis / S. Stavrakis, R. Lazzara, U.Thadani et al. // Journal of Cardiovascular Electrophysiology. – 2012. – Vol. 23. – P. 163–168.
5. Xue G. Is Right Ventricular Outflow Tract Pacing Superior to Right Ventricular Apex Pacing in Patients with Normal Cardiac Function? / G. Xue, Y. Su, W. Pan et al. // Clinical Cardiology. – 2009. – Vol. 32 (12). – P. 695–699.
6. Molina L. Medium-Term Effects of Septal and Apical Pacing in Pacemaker-Dependent Patients: A Double-Blind Prospective Randomized Study / L. Molina, M.D., R. Sutton, W. Gandoy et al. // Pacing and Clinical Electrophysiology. – 2014. – Vol. 37(2). – P. 207-214.
7. Dupont M. Differential response to cardiac resynchronization therapy and clinical outcomes according to QRS morphology and QRS duration / M. Dupont, J. Rickard, B. Baranowski et al. – Journal of American College of Cardiology. – 2012. – Vol. 60 (7). – P. 592-598.
8. Birnie D.H. Impact of QRS morphology and duration on outcomes after cardiac resynchronization therapy: Results from the Resynchronization-Defibrillation for Ambulatory Heart Failure Trial (RAFT) / D.H. Birnie, A. Ha, L. Higginson et al. // Circulation Heart Failure. – 2013. – Vol. 6(6). – P. 1190-1198.
9. Healey J.S. A randomized-controlled pilot study comparing ICD implantation with and without intraoperative defibrillation testing in patients with heart failure and severe left ventricular dysfunction: a substudy of the RAFT trial / J.S. Healey, L.J. Gula, D.H. Birnie et al. // Journal of Cardiovascular Electrophysiology. – 2012. – Vol. 23(12). – P. 1313-1316.