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DEVELOPMENT OF "FALSE" AV BLOCK IN A PATIENT AFTER HEART TRANSPLANTATION: CASE REPORT

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A clinical case of the development of bradycardia after heart transplantation is described. Electrocardiography data corresponded to atrioventricular (AV) block against the background of sinus bradycardia, which was the reason for the implantation of a pacemaker. Using intraprocedural electrophysiological study, the absence of data for AV dysfunction was revealed. The concept of AV block arose since the contracting part of the recipient's atria was electrically isolated from the donor's atria, there was no atrial activity in the donor heart, and the ventricles contracted due to AV node rhythm, which created the possibility for the presence of two dissociated rhythms.

Key words: transplanted heart; atrioventricular block; pacemaker; electrophysiological study

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Performing orthotopic heart transplantation (OHT) is often accompanied by the development of bradycardia, especially with the biatrial method of its implementation [1]. Moreover, the clinical variants of heart block are quite diverse. Conduction disorders may be both early postoperative and persist for a long period; be clinically insignificant or require temporary and permanent pacing; manifest as sinus dysfunction or atrioventricular (AV) block.

The most common type of conduction disorders is sinus dysfunction, which is due to performed operation technique [2]. With the biatrial OHT method, the posterior part of the right and left atrium of the donor with the preserved conduction system are anastomosed with the section of the right atrium of the recipient's heart containing the sinus node (SN). It turns out that created conditions in the patient's heart for the existence of two sinus nodes, despite the fact that the donor sinus node is anatomically and functionally denervated. Normally, the heart rate is determined by the intrinsic frequency of the sinus node, sinoatrial conduction, and a variety of other factors, the main of which is the influence of the autonomic nervous system. Exactly autonomic denervation, that is, the lack of sympathetic control over the donor heart, makes the main contribution to the manifestation of chronotropic incompetence. This situation develops in 50% of patients in the early postoperative period, and the need for temporary pacing depends on the severity heart rate decrease and the ineffectiveness of cardioton-

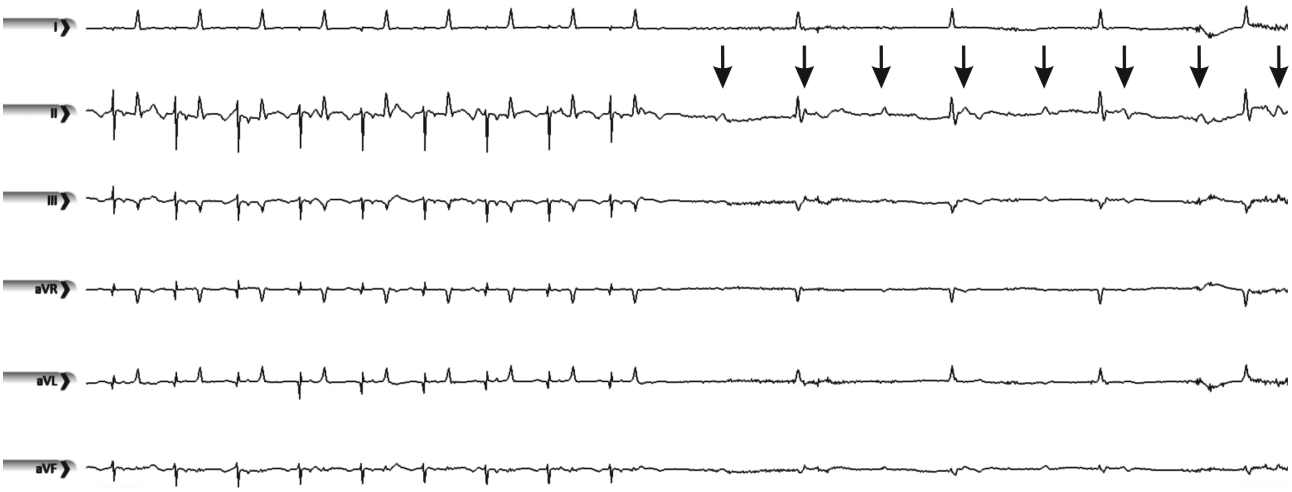

Fig. 1. Patient's ECG before pacemaker implantation. Efficient AAI pacing and sustained atrioventricular block when atrial pacing is turned off. Arrows indicate P- waves.

ic therapy [3]. It should be noted that in the absence of sympathetic innervation, the SN still able to change frequency of impulses generation in response to atrial distensibility due to venous return, as well as a result of the stimulating effect of circulating catecholamines [4]. In the future, some restoration of innervation of the SN region is observed, which, however, does not reach initial level.

It is generally accepted that development of early sinus dysfunction is not a predictor of undesirable outcome and in most cases tends to be eliminated within a few months to a year. On the contrary, in cases of implantation of pacemaker in the early stages, one often must deal with a situation in the future when the heart stimulation and consequently device is not required [5]. The emergence of the need for pacemaker implantation in the late OHT period is associated with a worse clinical prognosis. Therefore, all patients with longterm bradycardia or its development for more than 30 days require close examination in order to exclude rejection, vasculopathy, or myocardial ischemia affecting the SN area.

The development of AV block occurs much less frequently, with an unclear mechanism, and a rejection is considered as a possible cause. Blockade of conduction can develop up to second and third degree. Noted that prognosis for restoring an adequate rhythm in this case is worse, which requires implantation of a pacemaker in most cases [6]. In general, the implantation of a permanent pacemaker for all forms of conduction disturbance is required in 2-24% cases [7]. The presence of other rhythm disturbances: ventricular and atrial extrasystoles, episodes of atrial fibrillation and flutter, as a rule, does not have a significant independent significance, does not affect the prognosis and is corrected by medication.

As mentioned above, sinus dysfunction is the most common type of rhythm disturbance, but also the most studied. The development of permanent sinus dysfunction is multifactorial and includes such mechanisms as sinus node ischemia at the stage of donor heart delivery, features of the surgical stage, involvement of SN artery and variations of its anatomy, initial dysfunction of sinus node of the donor heart, development of myocardial fibrosis in response to taking immunosuppressants, rejection, inadequate response of the donor heart to influence of catecholamines [8].

Electrophysiological changes in the atria are described in detail by R.S. Bexton et al. (1984) [9]. Multielectrode mapping and electrophysiological tests were performed of the parts of donor and recipient atria. The obtained data indicated violations of the electrophysiological properties in both atria. Moreover, in the donor atrium, changes in the values of frequency of sinus rhythm, sinoatrial conduction, and the recovery time of the SN function were relatively homogeneous, which fit into the concept of denervation. At the same time, similar indicators of the recipient's atria were characterized by significant dispersion, in addition atrial fibrillation, sinus dysfunction and asystole occurred. This observation in recipients was interpreted by authors as possible initial disorders, altered blood supply to the SN of the recipient (collateral blood flow from the bronchial arteries is insufficient), as well as mentioned technical aspects of main operation.

If we examine the problem from the standpoint of the need for pacemaker implantation, so the decision to intervention should be made more than three weeks after OHT. Various surgicals approaches have been proposed when choosing a stimulation method [10]. Thus, nonphysiological singlechamber stimulation of the right ventricle (VVI) seems to be the most technically simple and reliable, and the main argument in its favor is the high probability of explantation of the pacemaker within the next year due to further inexpediency. Singlechamber right atrial stimulation (AAI) of the donor heart is physiological stimulation and, according to the authors, its advantage is the absence of an electrode in the ventricle, which does not interfere with myocardial biopsy. An interesting solution has been proposed for physiological control of the heart rate using two electrodes in the atrium (AAI r+d): the electrodes are implanted in the atria of recipient and donor and connected to the atrial and ventricular channels of dualchamber pacemaker, respectively. It is assumed that in this variant, the part of the recipient's atrium, which has retained autonomic control, will set the optimal rhythm for the donor's

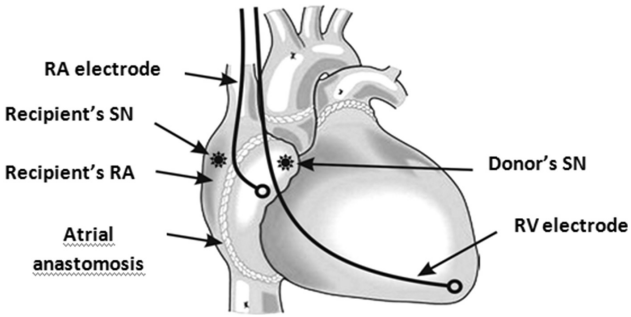

Fig. 2. The mechanism of development of the ECG pattern of atrioventricular block in patient G. The recipient's atrium contracts in isolation from the donor's right atrium, so when the pace-maker is turned off, an ECG picture of atrioventricular blockade is recorded, because of dysfunc-tion of atrial pacemaker in the donor's heart. When the pacing of right atrium is turned on, atri-oventricular conduction is normalized, since the right atrial electrode is placed in the donor's atrium.

Fig. 3. ECG recorded within one day. Top: Slopak leads I, II. Atrioventricular block is registered. Bottom: Slopack lead I, atrial rhythm with conduction via the atrioventricular node 1:1.

atria. However, this method has certain technical difficulties associated with the precise positioning of electrodes. It should also be considered that the recipient's atrium does not always have an adequate rhythm control function [9]. Nevertheless, the standard implantation of a dualchamber rate-adaptive (DDDR) pacemaker with electrodes in the donor atrium and ventricle has become more widespread. The rate adaptation of these devices allows to maintain an adequate chronotropic response, the presence of certain algorithms provides spontaneous conduction through the atrioventricular node, and ventricular stimulation is provided in AV block if necessary.

Patient G., 47 years old, with a diagnosis of dilated cardiomyopathy, underwent orthotopic heart transplantation using biatrial technique. The operation was carried out as standard: the total time was 250 minutes, the time of cardiopulmonary bypass - 112 minutes, the ischemia time - 80 minutes. During the first days after the operation sinus rhythm was recorded. Then, during the first week there was a change to an atrial rhythm with a gradual decrease in heart rate from 90 to 80 beats/min, which required temporary external pacing in the AAI mode through temporary epicardial electrodes sutured intraoperatively. A week after OHT, an endovascular myocardial biopsy from the right ventricle was performed. An episode of transient third-degree AV block was noted with a ventricular rate of 65 beats/min, which was regarded as a possible damage of the heart conduction system during biopsy. The Pace mode was changed to DDD with extended AV delay to preserve spontaneous conduction through the AV node. Subsequently, during a daily assessment of presence of spontaneous rhythm, now of turning off the pacemaker stably recorded AV block lasting up to several minutes, followed by restoration of conduction through the AVN 1:1 on the background atrial rate at about 80 beats/min. The obtained biopsy data did not indicate for rejection. Given the presence of persistent dysfunction of AV conduction at the background of chronotropic incompetence of atrial rhythm, on the 18th day after OHT (11th day after the biopsy), it was decided to implant a pacemaker in the DDDR mode. The pacemaker Adapta DR (Medtronic) was implanted with fixation of the ventricular electrode in the region of the apex of the right ventricle and the atrial electrode in the anterior septal region of the right atrium. However, during testing of implantable electrodes, an unusual clinical situation was noted. During atrial stimulation, both initially epicardially and endocardially during implantation, stable conduction via the AV node was recorded, but when stimulation was turned off, AV blockade was recorded with an atrial rate of 81 beats/min and 47 beats/min for the ventricles (Fig. 1). The subsequent resumed atrial pacing demonstrated the ability of the AV node to maintain stable 1:1 conduction to the ventricles at rates even greater than 130 bpm. The implanted pacemaker, due to AV conduction search algorithm (MVP), provided effective physiological atrial pacing with minimal ventricular pacing (V pace 0.1%).

Analyze this case, evaluating retrospectively ECG data and pacemaker testing data, we can conclude that this patient did not have even single episode of dysfunction AV node of the donor heart. The reason for the ECG picture of AV block was the asystole of the donor atrium with a escape AV junctional rhythm and contraction of the remaining portion of recipient's atrium. Atrial pacing via the temporary epicardial electrodes in donor's atria provided effective stimulation of the heart. At the same time, the activity of the atrial rhythm of the donor heart was suppressed by the the external pacemaker (Fig. 2).

It wasn't possible to assess the recipient's atrial function in the background of the work of a temporary pacemaker due to rarer frequency of spontaneous contractions. During ECG recording, trial cessation of stimulation demonstrated atrial arrest with restoration of atrial activity within a few seconds or later (Fig. 3). Draws attention to a different configuration of P-waves in the presence of AV block and without it, which can be explained by the restoration of pacemaker activity in the donor atrium with further conduction to the ventricles through the intact AV node. Pacemaker testing data also confirms the presence of transient donor's atria arrest (Fig. 4).

Fig. 4. Fragment of the endogram of the implanted pacemaker when stimulation is turned off (mode 0D0). Top. Rhythm from the atrioventricular node with retrograde conduction to the atria with blockade 2:1. Bottom. Recovery of atrial activity (indicated by the arrow) at a rate of 72 beats/min.

DISCUSSION

The described clinical case once again confirms that in terms of occurrence the development of AV blockade is significantly inferior to sinus dysfunction, because of technique of heart transplantation does not imply surgical damage to the area of atrioventricular node. According to literature data [6,8,10], the development of early AV block are extremely rare, and there is no clear expla-

nation of the pathogenesis of this complication. It is only assumed that as a mechanism for development of AV block may impact the technical difficulties at the stage of donor heart sampling and delivery, as well as the peculiarities of the operation itself. The factor of underexamination of the donor also plays an important role. For example, we previously described a clinical case of radiofrequency ablation after heart transplantation to a patient with occurrence of paroxysmal supraventricular tachycardia in the postoperative period due to the presence of concealed Wolff-Parkinson-White syndrome [11]. Early pacemaker implantation requires a balanced decision when there is no alternative to this method. On the other hand, the development of AV block, according to most authors, is associated with a worse prognosis in terms of restoration of AV conduction, which calls into a question the expediency of expectant approach.

In the described case, despite the absence of data for rejection, the erroneous conclusion of the development of AV block was based on its possible chronological relationship with the endomyocardial biopsy, which accelerated the decision to the need for pacemaker implantation. A certain contribution for the active tactic was also added by presence of the obvious sinus dysfunction. Sinus dysfunction in this patient, we assume, did not meet the criteria for autonomic denervation, because of asystole observed, but not a decrease in the frequency of impulses generation. The reason for this, probably, could be surgical damage of sinus node area during donor heart sampling or the almost complete absence of the donor's SN.

We consider that were made several shortcomings in the management of this patient, which led to adoption for a more active surgical approach. Initially, it was not paid sufficient attention to ECG data with and without AV block: this refers to the underestimation of P-wave morphology. There was no electrophysiological study of function of the conduction system of the heart, which could be performed through epicardial electrodes. However, further observation of the patient confirmed the presence of persistent insufficiency of atrial rhythm, which makes it possible to judge the correctness of decision to implant the pacemaker.

CONCLUSION

The development of bradycardia after OHT require a close study of the causes of its occurrence, the likelihood of reversibility of the process, the degree of chronotropic incompetence, the level of damage to the conduction system of the heart. It should be in mind that these patients are at high risk for the need of pacemaker implantation, which should be performed if indicated.

REFERENCES

1. Mallidi HR, Bates M. Pacemaker Use Following Heart Transplantation. *Ochsner J.* 2017;17(1): 20-24.
2. Scott CD, Omar I, Mccomb JM, et al. Long term pacing in heart transplant recipients is usually unnecessary. *Pace.* 1991;14: 1792-6. https://doi.org/10.1111/j.1540-8159.1991.tb02768.x.
3. Scott CD, Dark JH, McComb JM. Sinus node function after cardiac transplantation. *J Am Coll Cardiol.* 1994;24: 1334-1341. https://doi.org/10.1016/0735-1097(94)90117-1.
4. Rowan RA, Billingham ME. Myocardial innervation in long-term heart transplant survivors - a quantitative ultrastructural survey. *J Heart Transplant.* 1988;7: 448-52.
5. Mujamoto Y, Curtiss E, Kormos RL, et al. Bradyarrhythmia after heart transplantation: incidence, time course and outcome. *Circulation.* 1990;82(suppl IV): IV-313-7.
6. DiBiase A, Tse TM, Schnittger I, et al. Frequency and mechanism of bradycardia in cardiac transplant recipients and need for pacemakers. *Am J Cardiol.* 1991;67(16): 1385-1389. https://doi.org/10.1016/0002-9149(91)90469-2.
7. Woo GW, Schofield RS, Pauly DF, et al. Incidence, predictors, and outcomes of cardiac pacing after cardiac transplantation: an 11-year retrospective analysis. *Transplantation*. 2008;85(8): 1216-1218. https://doi.org/10.1097/TP.0b013e31816b677c.
8. Bacal F, Bocchi EA, Vieira ML, et al. Permanent and temporary pacemaker implantation after orthotopic heart transplantation. *Arq Bras Cardiol.* 2000;74: 9-12.
9. Bexton RS, Nathan AW, Hellestrand KJ, et al. The electrophysiologic characteristics of the transplanted heart. *Am Heart J.* 1984;107(1): 1-7. https://doi.org/10.1016/0002-8703(84)90124-8.
10. Thompson MA, Patel H. Posttransplant pacemaker placement: case series and review. *Ochsner J*. 2010;10(4): 236-40.
11. Mamchur SE, Malyshenko ES, Khomenko EA, et al. The Wolff-Parkinson-White syndrome of heart allograft and catheter ablation of accessory pathway after orthotopic heart transplantation. *Complex Issues of Cardiovascular Diseases*. 2014;4: 33-37 (In Russ.). https://doi.org/10.17802/2306-1278-2014-4-33-37.