Does the surgical technique used in the orthotopic heart transplant affect the results regarding the rhythm?

Ortotopik kalp naklinde kullanılan cerrahi teknik ritm ile ilgili sonuçları etkiler mi?

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ABSTRACT

Objective: The aim of this study was to compare the requirement for temporary and permanent pacemaker insertion and the incidence of the problems regarding the rhythm following heart transplantation with the bicaval or biatrial technique in the early postoperative period.
Methods: Sixty-one patients underwent orthotopic heart transplantation between the dates of September 1989 and December 2008 in our clinics were included to the study. The study was designed as retrospective analysis, and all data were collected from hospital records. The transplantation was performed by using standard biatrial method in 28 of the patients, by using bicaval anastomosis method in 33 of the patients. Statistical analyses were performed using Chi-square, Fischer's exact and Mann-Whitney U tests. Predictors of temporary and permanent pacemaker insertion were analyzed using logistic regression analysis.
Results: In the biatrial group, the temporary pacemaker requirement ($p<0.05$), left bundle branch block (LBBB) ($p<0.01$) and atrioventricular block (AV block) ($p<0.05$) were observed statistically significantly more than in bicaval anastomosis group. In addition, in the biatrial group, one patient needed implantation of permanent pacemaker and one patient-implantable cardioverter defibrillator. On the postoperative echocardiographic evaluation, in the patients operated with the bicaval technique, the tricuspid ($p<0.01$) and mitral insufficiency ($p<0.01$) were observed significantly less. In the logistic regression analysis, hypertension (OR: 1.053, 95% CI: 1.019-1.176, $p<0.05$), donor age (OR: 1.016, 95% CI: 1.023-1.038, $p<0.05$) and application of the operation with the biatrial technique (OR: 10.287, 95% CI: 1.298-91.278, $p<0.01$) were determined as the risk factors requiring the temporary pacemaker usage. In the bicaval group, arrhythmia (ventricular and atrial premature beats) and atrioventricular valve insufficiency were observed less, the rhythm returned to normal in an earlier period.
Conclusion: Biatrial surgical technique, donor age and hypertension were determined as significant predictors of temporary pacemaker insertion in the orthotopic heart transplantation. Atrioventricular block, left bundle branch block, and arrhythmia frequency was significantly less in the bicaval group. In terms of factors affecting morbidity, the bicaval technical results were found superior than biatrial technique.
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Key words: Cardiac transplantation, surgery, artificial pacemaker, arrhythmia, logistic regression analysis

ÖZET

Amaç: Bu çalışmanın amacı, bikaval ya da biatrial teknik ile kalp naklini takiben kalıcı ve geçici kalp pili gereksinimi ve ritim ile ilgili problemlerin sıklığını karşılaştırmaktır.
Yöntemler: Kliniğimizde Eylül 1989 ile Aralık 2008 yılları arasında ortotopik kalp nakli yapılan 61 hasta çalışmaya dahil edildi. Bu çalışma retrospektif analiz olarak dizayn edildi ve hastalara ait veriler hastane kayıtlarından toplandı. Hastaların 28'ine standart biatriyal, 33'üne bikaval anastomoz tekniği kullanılarak nakil yapıldı. İstatistiksel analiz χ^2, Fischer's exact ve Mann-Whitney U testleri ile yapıldı. Geçici ve kalıcı pacemaker için prediktörler lojistik regresyon analiz ile incelendi.
Bulgular: Biatriyal grupta geçici pacemaker gereksinimi ($p<0.05$), sol dal bloğu (LBBB) ($p<0.01$) ve atriyoventriküler blok ($p<0.05$) istatistiksel olarak anlamlı oranda daha fazla olduğu görüldü. Ayrıca biatriyal grupta 1 hastanın kalıcı pacemaker ve 1 hastanın takılabilen kardiyoverter defibrilatöre ihtiyacı oldu. Postoperatif ekokardiyografik değerlendirmede bikaval teknikle opere edilen hastalarda, triküspit ($p<0.01$) ve mitral yetmezliği ($p<0.01$) anlamlı olarak daha az gözlemlendi. Tek değişkenli analizde, hipertansiyon (OR: 1.053, %95 GA: 1.019-1.176, $p<0.05$), donör yaşı (OR: 1.016, %95 GA: 1.023-1.038, $p<0.05$) ve biatriyal cerrahi teknik uygulanması (OR: 10.287, %95 GA: 1.298-91.278, $p<0.01$) geçici pace gereksinimi için risk faktörleri olarak tespit edildi. Bu hastalarda, aritmi (ventriküler ve atriyal erken vurular) ve atriyoventriküler kapak yetmezliği daha az gözlendi, ritm daha erken sürede normale döndü.

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Sonuç: Ortotopik kalp naklinde biatriyal cerrahi teknik, donör yaşı ve hipertansiyon geçici pacemaker gereksinimi için önemli belirleyiciler olarak tespit edildi. Atriyoventriküler blok, sol dal bloğu ve aritmi sıklığı bikaval grupta anlamlı olarak daha az görüldü. Morbiditeyi etkileyen bu faktörler bakımından bikaval teknik sonuçları biatriyal teknikten üstün bulundu. *(Anadolu Kardiyol Derg 2012; 12: 255-60)*
Anahtar kelimeler: Kalp nakli, cerrahi, yapay kalp pili, aritmi, lojistik regresyon analizi

Introduction

The biatrial surgical technique which was defined by Lower and Shumway in the year of 1960 for the heart transplantation was adopted by the surgeons all over the world for a long time and has been successfully applied since (1, 2). With the aim of preventing the complications belonging to the right heart encountered after the standard orthotopic heart transplant, in the year of 1991, Wythens technique was developed (3).

In the biatrial anastomosis technique, the atriums anatomical structure and geometrical shape are changing; the unsynchronized atrial contractions can cause regurgitation in the tricuspid and mitral valve. In the bicaval anastomosis technique, the atrial tissue holding on vena cava are left in cuff form and the almost all of the recipient right atrial tissue is removed. Donor`s inferior and superior vena cava are directly made anastomosis to the recipient atrial cuffs. By this way, the donor right atrium anatomy is protected and the possible sinus node damage is prevented. In the bicaval technique, the sinus node function is not disordered, as a result of the atrial contractions the stroke volume and heart performance become better (3). Also in the bicaval technique, with the protection of the right atrial anatomy, the atrioventricular valve function is also protected.

The sinus node dysfunction is one of the most common reasons of the morbidity after the orthotopic heart transplant. It was noticed that the frequency of the sinus node dysfunction following the orthotopic heart transplant varied between 10% and 43% (4). The surgical trauma, sinus node ischemia, rejection, drug treatment and increase of donor age can be shown as the etiology of the sinus node dysfunction (5, 6). Although the bicaval surgical technique in the orthotopic heart transplant is more prevalently preferred in the recent years, both techniques are also used and there is no consensus on which technique is required to be used.

In our study, we compared the temporary and permanent pacemaker requirements of the patients who had transplant with biatrial and bicaval anastomosis technique and their problems regarding the rhythm.

Methods

Study design and patient's population

We retrospectively reviewed medical records of all patients who underwent orthotopic heart transplantation at Kartal Koşuyolu Yüksek İhtisas Education and Research Hospital between the dates of September 1989 and December 2008. A total 61 patients had orthotopic heart transplantation. The patients were divided into two groups according to the applied surgical technique: standard biatrial-28 patients - and bicaval technique-33 patients-were applied. The mean age was respectively 31.8±12.5 (16-58) years in the standard biatrial group and 29.8±9.9 (17-48) years in bicaval group. The etiology was dependent on dilated cardiomyopathy (mostly ischemic) in 23 of the patients in the standard group (82.1%), on other reasons in remaining 5 (17.9%) of this group and on dilated cardiomyopathy (mostly ischemic) in 27 of the patients in the bicaval group (81.8%), on other reasons in 6 of them (18.2%).

Transplantations were performed using biatrial technique until 2004; while the bicaval technique was used during the period of between 2004-2008.

The majority of the biatrial transplantations were performed by two different cardiac surgeons and the majority of the bicaval transplantations were by six different cardiac surgeons.

Clinical variables and data collection

We retrospectively reviewed medical records of all patients who underwent orthotopic heart transplantation (from the case notes, doctor's observation notes, nurse follow-up forms, and intensive care charts). These included: gender, donor age, recipient age, primary diagnosis, risk factors (hypertension, diabetes mellitus, chronic obstructive pulmonary disease, pulmonary artery pressure, renal functions, family history), echocardiographic findings, days to discharge, requirement for temporary and permanent pacemaker, incidence of atrial tachyarrhythmias (atrial fibrillation, atrial flutter, supraventricular tachycardia), atrioventricular (AV) block type and degree, arrhythmia type (atrial and/or ventricular), perioperative findings (cross-clamp time, ischemia time, cardiopulmonary bypass time).

Rhythm follow-up in the early postoperative period

Twenty-four-hour telemetric monitoring was performed for a minimum of 5 days in all patients, and for longer periods in those in whom it was thought necessary. Then 12- lead electrocardiography was performed once a day until discharge. In the postoperative period, patients were given cardioactive drugs (isoprenaline, dopamine, dobutamine, adrenaline) in order to achieve positive chronotropic and inotropic effect as required. Temporary pacemaker was used to maintain a resting heart rate of at least seventy beats per minute in the first month. Temporary stimulation was undertaken with epicardial electrode pacing during the surgical procedure or, if necessary, an endocardial electrode was positioned by right internal jugular vein puncture. Permanent pacemaker is inserted if the need for temporary pacemaker was more than three weeks after cardiac transplantation.

Immunosuppressive treatment and rejection

The majority of the patients received triple-drug combination (cyclosporine 5-10 mg/kg/day, corticosteroid 1 mg/kg/day, azathioprine 1-2 mg/kg/day) for immunosuppressive therapy. Changes in immunosuppression protocols were made at last the period of the study. Maintenance of immunosuppression included prednisone, mycophenolate mofetil, and cyclosporine or tacrolimus. The endomyocardial biopsy (EMB), cytoimmunologi-

cal monitorization, echocardiography and pace electrocardiography were used for patients monitoring and rejection follow-up. In case the methylprednisolone was not successful in the acute rejection therapy, anti-thymocyte globulin (ATG) and octreotide 3 (OCT3) were used. In the acute rejection, EMB was applied in limited numbers except the first patients.

Surgical technique

The donor cardioectomy was similar in both groups. The place to which the pulmonary veins were opened was removed together with the surrounding left atrium tissue. The place between the aorta and pulmonary artery was separated with sharp dissection. In the standard technique, by starting from the right atrium vena cava inferior (IVC), it was opened to the right atrial appendix with a right incision. In the bicaval group, the right atrium was left intact.

The recipient's operation was started after donor heart was brought to the operation room and controlled again. After median sternotomy, in both groups, the aorta was cannulated from a place near to the innominate artery. The vena cava was cannulated, the cava's sneers were squeezed, and the cardiopulmonary bypass was initiated. In the biatrial group, the pulmonary veins opened to the left atrium were prepared in a way forming a single stitch line and as a wide orifice by leaving right atrium sufficient stitch line. The aorta and pulmonary artery were transected from the supravalvular level. Firstly left atrial anastomosis and then respectively, right atrium, pulmonary artery and aorta anastomoses were performed. In the bicaval group, there were no changes in the surgical approach and cannulation. The right atrium was excised fully in a way in which 3-4 mm atrial tissue is left from vena cava superior (SVC) junction and in which 1-1.5 cm atrium tissue is left on IVC side. The left atrium was excised like the pulmonary artery and aorta in standard group. Respectively left atrium, IVC, SVC, pulmonary artery and aorta anastomoses were performed.

Statistical analysis

The statistical analyses were accomplished by using SPSS 13.0 for Windows program (Chicago, IL, USA). Continuous variables are expressed as mean±SD and categorical variables - as percentage/ numbers. The differences among the categorical variables were evaluated with Chi-square and Fisher's exact tests, the continuous and discrete data were evaluated with Mann-Whitney U test. Paired t-test was used for evaluating the pre- and postoperative changes in the pulmonary artery pressure. The independent risk factors were evaluated with the logistic regression analysis. Logistic regression with purposeful selection modeling was used to identify significant predictors of temporary pacemaker insertion. A p value < 0.05 was accepted as significant.

Results

Preoperative findings

The demographic data of both groups are presented in Table 1. There were no statistically significant differences between two groups. The comparison of the preoperative risk factors are given in Table 1. Among the risk factors other than chronic obstructive pulmonary disease ($p<0.05$), there were no significant differences.

Perioperative findings

The perioperative findings are given in the Table 2. While there were no differences in terms of cross-clamp time, donor heart's ischemia time and hypothermia, in the patients operated with the bicaval technique total perfusion time was longer ($p<0.05$) than in biatrial group. It was observed that the hospitalization duration was shorter in the patients in the bicaval group ($p<0.05$).

Postoperative findings

Echocardiographic findings

In the postoperative echocardiographic evaluation, in the patients operated with the bicaval technique, tricuspid ($p<0.01$) and mitral insufficiency ($p<0.01$) were observed as less significant. There were no statistically significant differences among the other parameters. The postoperative rhythm problems and echocardiographic findings are presented in the Table 3.

Temporary pacemaker insertion

Following the orthotopic heart transplant, temporary pacemaker was inserted to 10 patients from the standard group (35.7%) and to 3 patients (9.1%) from the bicaval group, ($p<0.05$). The indications for temporary pacemaker insertion reason

Table 1. Comparison of groups for preoperative risk factors and demographic data

Parameters	Bicaval group (n=33)	Biatrial group (n=28)	*p
Gender, male/female, n (%)	26 (78.8)/7 (21.2)	24 (85.7) /4 (14.3)	0.483
Donor age, years	29.8±9.9 (17-48)	31.8±12.5 (16-58)	0.582
Recipient age, years	33.47±12.67	31.96±13.84	0.487
Etiologic factors			
DCMP, n (%)	27 (81.8)	23 (82.1)	1.000
Other, n (%)	6 (18.2)	5 (17.9)	
Pulmonary artery pressure, mmHg	51.4±12.7 (35-80)	47.3±9.7 (30-70)	0.167
LVESD, cm	6.1±0.9 (4.7-7.9)	5.9±0.9 (3-7.8)	0.302
LVEDD, cm	7.1±0.9 (6-9)	6.9±0.9 (4-9)	0.447
Ejection fraction, %	21.5±4.3 (12-33)	24.6±6.9 (15-50)	0.065
Pulmonary vascular resistance, dyn·s·cm	147.3±77.8	148.2±8.1	0.964
Diabetes mellitus, n (%)	1 (3)	3 (10.7)	0.325
Hypertension, n (%)	5 (15.2)	9 (32.1)	0.116
COPD, n (%)	3 (9.4)	8 (28.6)	0.034
Renal failure, n (%)	3 (9.1)	3 (10.7)	1.000
Family history, n (%)	8 (24.2)	13 (46.4)	0.069

Data are expressed as mean±SD (min-max) values and proportion/percentage
*Fischer's exact, Chi-square and Mann-Whitney U tests
COPD - chronic obstructive pulmonary disease, DCMP - dilated cardiomyopathy, LVEDD - left ventricular end - diastolic diameter, LVESD - left ventricular end - systolic diameter

were: in the biatrial group- sinus node dysfunction in 7 patients, type II 2nd degree AV block in 2 patients and complete AV block in one patient; in the bicaval group-type II 2nd degree AV block in 2 patients and persistent bradycardia one patient.

In the early postoperative period (first two weeks), 9 patients in the standard group had temporary pacemaker requirement, while in the bicaval group there were no patients requiring temporary pacemaker.

In the late postoperative period (after second week), one patient in the standard group and 3 patients in the bicaval group had a requirement for a temporary pacemaker implantation. Of these patients, one patient in the standard group died on the 13th day because of the acute rejection attack, one patient died on the 3rd week because of right ventricle insufficiency and one patient died on the 2nd month because of common pulmonary fungi infection. In the bicaval group, one patient died on the 2nd month because of rejection attack.

In the logistic regression analysis, hypertension (OR 1.053, 95% CI: 1.019-1.176, p< 0.05), donor age (OR 1.016, 95% CI: 1.023-1.038, p<0.05) and application of the operation with the biatrial technique (OR 10.287, 95% CI: 1.298-91.278, p<0.01) were determined as the risk factors requiring the temporary pacemaker usage (Table 4).

Table 2. Comparison of peroperative data

Variables	Bicaval group (n=33)	Biatrial group (n=28)	*p
Cross-clamp time, min	77.4±15.1 (50-123)	73.9±13.6 (48-108)	0.350
Cardiopulmonary bypass time, min	144.4±20.8 (81-170)	127.7±19.5 (82-172)	0.012
Donor ischemic time, min	158±52.6 (55-270)	175.3±28.8 (112-215)	0.109
Hospital stay, days	20.6±25.3	26.5±31.8	0.021
Hospital mortality, n (%)	1 (3.2)	3 (10.7)	0.257

Data are expressed as mean±SD (min-max) values and proportion/percentage
*Fischer's exact test and Mann-Whitney U test

Table 3. Comparison of postoperative and echocardiographic data

Variables	Bicaval group (n=33)	Biatrial group (n=28)	*p
Permanent pacemaker insertion, n (%)	0	1 (3.6)	0.459
Temporary pacemaker insertion, n (%)	3 (9.1)	10 (35.7)	0.011
Atrial fibrillation, n (%)	2 (6.3)	4 (14.3)	0.404
Atrial flutter, n (%)	6 (20)	11 (39.3)	0.107
SVT, n (%)	2 (6.3)	4 (14.3)	0.404
Arrhythmia, n (%)	5 (15.2)	12 (42.9)	0.016
AV block, n (%)	2 (6.1)	8 (28.6)	0.034
Left bundle branch block, n (%)	0	6 (21.4)	0.007
MR, n (%), grade	10 (31.3), 2-4	20 (71.4), 2-4	0.005
AR, n (%), grade	1 (3.2), 0-1	3 (10.7), 0-1	0.257
TR, n (%), grade	13 (42), 2-4	23 (82.1), 2-4	0.001
Ejection fraction, %	61.7±8.5 (30-75)	64.1±6.1 (50-75)	0.325
Pulmonary artery pressure, mmHg	36.1±9.8 (20-65)	37±8.4 (20-62)	0.708
LVESD, cm	2.7±0.4 (1.8-3.4)	2.8±0.5 (2.1-4.4)	0.284
LVEDD, cm	4.2±0.4 (3.2-5)	4.4±0.5 (3.4-5.8)	0.207
LA, cm	3.5±0.7 (2-5.4)	3.8±0.8 (2.6-6.1)	0.150

Data are expressed as mean±SD (min-max) values and proportion/percentages
*Fischer's exact, Chi-square and Mann-Whitney U tests
AR - aortic regurgitation, AV - atrioventricular, LA - left atrium, LVEDD - left ventricular end -diastolic diameter, LVESD - left ventricular end - systolic diameter, MR - mitral regurgitation, SVT - supraventricular tachycardia, TR - tricuspid regurgitation

Permanent pacemaker insertion

In terms of permanent pacemaker implantation, there were no statistically significant differences between two groups. In the standard group implantable cardioverter defibrillator (ICD) implantation was applied to one patient due to the sinus node dysfunction the permanent pace and to one patient due to the ventricular tachycardia attacks. In the bicaval group, there were no patients requiring the permanent pace.

Arrhythmia, atrioventricular block, atrial tachyarrhythmia

When two patient`s groups were compared, in the bicaval anastomosis technique, arrhythmia (p<0.05), AV block (p<0.05) and left bundle branch block (LBBB) (p<0.001) frequencies were statistically less than in standard group. Although the atrial tachyarrhythmia (atrial fibrillation, atrial flutter and supraventricular tachycardia) were no statistically significant, it was more observed in the standard group than the bicaval group. No risk factors affecting the postoperative AV block (type II 2nd degree and complete AV blocks), atrial fibrillation and arrhythmia frequency were determined. Overall comparison of bicaval and standard anastomoses regarding the rhythm data are presented in the Figure 1.

Discussion

The results of this study demonstrated that, in the bicaval anastomosis technique; requirement for temporary pacemaker insertion, arrhythmia, AV block and LBBB frequency were statistically less than standard group. Although the atrial tachyarrhythmia (atrial fibrillation, atrial flutter and supraventricular tachycardia) were no statistically significant, it was more observed in the standard group than the bicaval group.

Although the application in the world is more common, in spite of the increase in the recent years in our country, the heart transplant is not at the desired level. That is because of the difficulties in finding the donor heart. Therefore, the surgical technique to be applied to the patient taken to the heart transplant program becomes more crucial. Although bicaval surgery technique in orthotopic heart transplantation is preferred commonly in orthotopic heart transplantation, still there is no any common consensus in that respect.

Sinus node dysfunction is one of the reasons of morbidity after orthotopic heart transplantation. Frequency of sinus nod dysfunction after orthotopic heart transplantation was reported between 10-43% (4, 7, 8). It was reported that permanent pacemaker application ratio in sinus nod dysfunction as 3-19% (4, 7, 8). Biatrial technique could cause trauma in sinus node or on its

Table 4. Logistic regression analysis of factors affecting temporary pacemaker insertion

Variables	OR	95% CI	*p
Donor age	1.016	1.023-1.038	0.036
Recipient age	0.879	0.822-1.084	0.815
Gender	1.056	0.678-1.496	0.966
Ischemic time	0.936	0.978-1.003	0.267
Cross-clamp time	0.893	0.893-1.032	0.285
Recipient ejection fraction	1.477	0.471-7.735	0.532
Recipient PAP	1.063	1.016-1.274	0.341
Technique	10.287	1.298-91.278	0.019
Hypertension	1.053	1.019-1.176	0.034
Rejection	1.586	0.291-7.654	0.499
PVR	1.004	0.978-1.027	0.286
Operation date	1.009	1.003-1.118	0.316

PAP - pulmonary arterial pressure, PVR - pulmonary vascular resistance

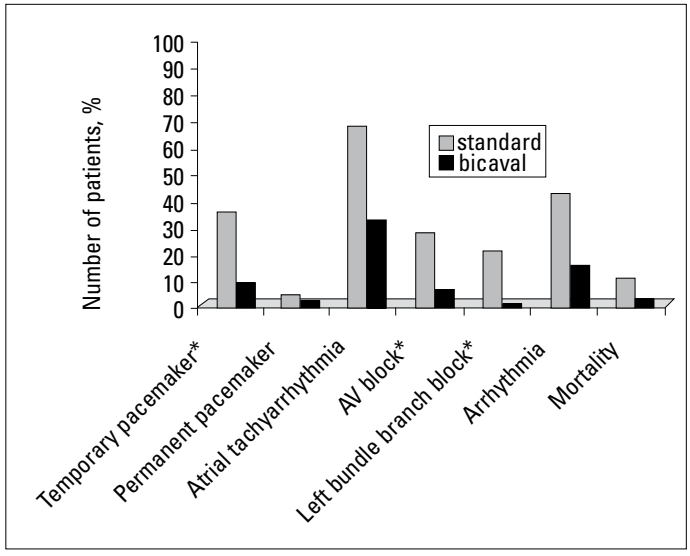

Figure 1. Comparison of perioperative rhythm data according to the use of surgical technique. Asterisks indicate statistically significant differences
AV block includes type II 2nd degree AV block and complete AV block
Atrial tachyarrhythmia includes atrial fibrillation, atrial flutter and supraventricular tachycardia
AV - atrioventricular

perinodal tissue and could impair its normal atrium morphology (5, 8, 9). In bicaval technique, almost the whole recipient right atrium could be excised and an atrial cuff could be left. Donor vena cava inferior and superior could be anastomosed to recipient atrial cuff directly. Thus, right atrium anatomy of donor could be protected and any possible sinus nod damage could be prevented (10). When transplantation is applied with standard technique, anatomical structure and geometrical formation of atriums are changed and unsynchronized atrial contractions could cause regurgitation on tricuspid and mitral valve (11).

In more than 50% of the recipients, just after the heart transplant or within the first week, sinus or junctional bradycardia appears (6, 9). The donor sinus node dysfunction has been declared as the most frequent reason of the bradyarrhythmia after the transplant. In getting the bradyarrhythmia under control, medical treatment is used. If the response is not observed with the medicines, there is an indication for temporary pacemaker. It has been declared that the temporary and permanent pace incidence have changed between 4% and 24% in some studies (7, 12). Locali et al. (13) indicated that postoperative arrhythmia frequency was decreased in bicaval group significantly; however, Schnoor et al. (14) indicated that in bicaval group sinus rhythm was higher.

Meyer et al. (10) informed that although the cross-clamp and ischemia duration is prolong, with the bicaval technique, within 30 and 90 days following the heart transplant, the permanent pacemaker requirement decreased in the statistically significant rate and was safe. In our study demonstrated that there are no differences in terms of cross-clamp time and donor heart's ischemia time, in the patients operated with the bicaval technique cardiopulmonary bypass time was longer than biatrial group but that the hospitalization duration was shorter in the patients in the bicaval group. Some authors (15, 16) reported that atrial geometry was protected better by the bicaval anastomosis technique; the incidence of postoperative atrial tachyarrhythmia was low, need for pacemaker was decreased and was discharged from hospital earlier. According to United Network for Organ Sharing/Organ Procurement and Transplantation Network (UNOS/OPTN) multivariable analysis results published by Cantillon et al. (17) in 2010, it was reported that bicaval surgery technique was a powerful protector against postoperative pacemaker requirement. Also in the same study, it was reported that biatrial surgery technique and increasing donor/recipient age was related to postoperative pacemaker requirement. In our study, while in 10 of 28 patients from the standard group temporary pace need occurred, in 3 of 33 patients from the bicaval group temporary pace need occurred. It was observed that in the patients operated with the biatrial technique, the temporary pacemaker need was significantly more ($p<0.05$). In terms of the permanent pacemaker usage, there were no significant differences among the groups. While one patient from the standard group had permanent pacemaker need, there were no permanent pace requirements in the patients in the bicaval group.

El-Gamel et al. (18) stated that in their 85 patient working groups, with the bicaval technique the right atrial pressure was lower, the atrial tachyarrhythmia was encountered less, the mitral incompetence was less and the diuretic dose need was less. Cui et al. (19) in their studies reported that in the patients in which the biatrial anastomosis technique is used, the atrial flutter incidence was significantly high but the atrial fibrillation was similar in both technique. In our study, when two groups were compared arrhythmia (ventricular or atrial premature beats and extrasystoles), ($p<0.05$), AV block ($p<0.05$) and LBBB ($p<0.01$) were observed less in the bicaval group. Also, although there were no statistically significant difference, the atrial tachyarrhythmia (atrial fibrillation, flutter and supraventricular tachycardia) requiring treatment was observed more frequently in the standard group.

The ones defending the bicaval technique informed that the atrium geometry became unbalanced, the contractions of two atrium parts coincided and this could cause tricuspid insufficiency in the postoperative early period. They informed that the mitral insufficiency was related to the distortion of the posterior

leaflet, which is the continuation of the left atrium endocardium depending on the extension of the left atrium part, which was made anastomosis (5, 9). Solomon et al. (20) in their 75-week study, informed with the bicaval technique, the central venous pressure was lower, the tricuspid insufficiency was less and there was not any important difference among both groups in terms of pace usage. Park et al. (21) in their study compared the tricuspid insufficiencies in the 1st and 3rd year of both groups; it was observed that the tricuspid insufficiency was higher in the standard group. Transversi et al. (22) showed that the echocardiographic results of the left and right atrial functions were better than standard technique and that with the bicaval anastomosis technique, the atrial volumes were smaller.

In our study, the tricuspid insufficiency ($p<0.01$) and mitral insufficiency ($p<0.01$) were found during the postoperative follow-up less significant in the bicaval group. While the atrioventricular valve insufficiencies were analyzed, the medium and advanced insufficiencies were evaluated.

Study limitations

The first of the limitation of this study was neither prospective nor randomized, data collected retrospectively. The number of patients was not very large but quite enough to compare both groups. It would have been better if this study were carried with a larger sample size.

Conclusion

The results of our study support the literature findings on that with the bicaval anastomosis technique the right atrial anatomy can be better protected, the sinus node dysfunction and atrioventricular valve insufficiency are observed less. However, in terms of both surgical technique, the long- term results are still contradictory and they change according to the used surgical technique, experience of the clinics and surgeon. In a point of view, by decreasing the rhythm related complications, the bicaval technique, which we think may decrease the morbidity in the early postoperative period and increasing the patient survival became a preferred technique in our clinics.

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