

## Precise placement of temporary pacing wire after coronary artery bypass grafting surgery: is the left ventricle or right ventricle more convenient?

*Koroner arter bypass greftleme ameliyatı sonrası geçici telin en uygun yerleştirilmesi:  
Sol ventrikül mü yoksa sağ ventrikül mü daha uygundur?*

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**Background:** In this study, the left ventricular asynchrony of pacemakers in patients with possible need for a pacemaker in the postoperative period after coronary artery bypass grafting surgery was investigated.

**Methods:** Eighteen consecutive patients (13 males, 5 females; mean age 66.2±12.4; range 47 to 77 years) undergoing coronary artery bypass grafting who were candidates for a pacemaker placement postoperatively were included in the study. Temporary epicardial pacing wires were intraoperatively placed both on the right ventricle (RV) and on the left ventricle (LV) in all patients. The epicardial wires were placed on the RV to the outflow tract and on the LV to the apex. On the fifth postoperative day echocardiography (Vivid 5, Vingmed, General Electric Healthcare) was performed and tissue Doppler measurements were taken during basal, RV pacing and LV pacing. During RV and LV pacing, the heart rate was increased above the basal rate. During the analysis, at least three cardiac cycles were recorded in the tissue velocity imaging mode. The recorded images were analyzed by EchoPAC (EchoPAC 6.3, Vingmed-General Electric Healthcare). In the images that were collected for tissue synchronization LV septal and lateral segments were marked and were subsequently analyzed for delay in the septo-lateral segment. The results were shown in mean ± standard deviation and statistical analysis was performed using the Wilcoxon signed rank test (p<0.05).

**Results:** In all patients, during RV pacing significant intraventricular delay was documented between the septum and the lateral wall (52.9±20.7 ms versus 20.6±14.6 ms, p<0.001). During LV pacing in all patients intraventricular delay was measured shorter than the basal value (12.7±12.1 ms versus 20.6±14.6 ms, p=0.001). No complications were observed in all patients during the placement of intraoperative pacemaker wire, in the postoperative period when asynchrony measurements were performed and after the removal of the wires.

**Conclusion:** In patients undergoing coronary artery bypass grafting surgery the temporary epicardial pacing wires should be placed on the left ventricle instead of the right ventricle.

**Key words:** Artificial cardiac pacing/methods; cardiomyopathy, dilated/therapy; coronary artery bypass grafting surgery; echocardiography, Doppler; left ventricle; right ventricle.

**Amaç:** Koroner arter bypass greftleme ameliyatı uygulanan ve ameliyat sonrası dönemde geçici kalp pili gereksinimi olan hastalarda kalp piline bağlı oluşan sol ventrikül asenkronisi değerlendirildi.

**Çalışma planı:** Koroner arter bypass greftleme ameliyatı uygulanan ve ameliyat sonrası dönemde kalp pili gereksinimi olacağı düşünülen ardışık 18 hasta (13 erkek, 5 kadın; ort. yaş 62.0±15.0 yıl; dağılım 47-77 yıl) çalışmaya dahil edildi. Ameliyat sırasında hastaların tümüne sağ ventrikül (sağV) ve sol ventrikül (solV) epikardlarına geçici kalp pili telleri yerleştirildi. Epikardiyal teller sağV'de çıkım yoluna, solV'de apekse yerleştirildi. Ameliyat sonrası 5. günde ekokardiyografi (Vivid 7, Vingmed-General Electric Healthcare) ile bazal, sağV ve solV yerleştirilmesi sırasında doku Doppler ölçümleri yapıldı. SağV ve solV yerleştirilmesi sırasında kalp hızı kalp pili ile bazal değer üzerine çıkartıldı. Analiz sırasında en az üç kardiyak siklus doku hız görüntüleme modunda kaydedildi. Kaydedilen görüntüler EchoPAC (EchoPAC 6.3, Vingmed-General Electric Healthcare) cihazı ile analiz edildi. Doku senkronizasyon görüntüleme için alınan görüntülerde, solV septal ve lateral segmentler işaretlendi ve septo-lateral gecikme olup olmadığı kaydedildi. Sonuçlar ortalama ± standart sapma olarak gösterildi ve ortalamaların karşılaştırılmasında Wilcoxon signed rank test kullanıldı.

**Bulgular:** Hastaların tümünde sağV yerleştirilmesi sırasında septum ile lateral duvar arasında bazal değerlere oranla belirgin intraventriküler gecikme meydana geldi (52.9±20.7 ms'ye karşın 20.6±14.6 ms, p<0.001). SolV yerleştirilmesi uygulandığında tüm hastalarda intraventriküler gecikme bazal değerlerden daha kısa ölçüldü (12.7±12.1 ms'ye karşın 20.6±14.6 ms, p=0.001). Hastalarda ameliyat sırası kalp pili teli yerleştirilirken, ameliyat sonrası dönemde asenkroni ölçümleri yapılırken ve teller alındıktan sonra hiçbir komplikasyon görülmedi.

**Sonuç:** Koroner arter bypass greftleme ameliyatı uygulanan hastalarda geçici epikardiyal pace tellerinin sağ ventrikül yerine sol ventriküle yerleştirilmesi daha uygundur.

**Anahtar sözcükler:** Yapay kalp pili/yöntem; kardiyomiyopati, dilate/terapi; koroner arter bypass greftleme ameliyatı; ekokardiyografi, Doppler; sol ventrikül; sağ ventrikül.

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Intraventricular mechanical asynchrony is the term used for the action that is not performed by simultaneous movements of all the segments of the left ventricle (LV) during systole. The critical value for systolic asynchrony is considered as the difference of 60 ms or of a greater value between the measurements that are collected from septum and basal parts of the lateral segments.<sup>[1-3]</sup> The asynchronous contractions cause a decrease in the performance of the left ventricular systolic functions.<sup>[4]</sup> The hemodynamic deterioration that is caused by this event may result in the development of heart failure or deterioration of preexisting heart failure. The delay in conduction inside the LV is demonstrated as a more important factor in determining mortality than mean right atrial pressure, pulmonary capillary wedge pressure, arrhythmias that are ventricular in origin and ejection fraction.<sup>[5]</sup> Bader et al.<sup>[6]</sup> have found in their study that LV asynchrony is a bad prognostic factor. In our study, our goal was to investigate the LV asynchrony in patients with possible need for a pacemaker in the postoperative period after coronary artery bypass surgery.

## PATIENTS AND METHODS

### Patient population

A total of 18 consecutive patients (13 males, 5 females; mean age  $66.2 \pm 12.4$  years; range 47 to 77 years) undergoing coronary artery bypass grafting who were candidates for a pacemaker placement postoperatively were included in the study. All patients provided written informed consent. Twelve of the patients (66%) had previous myocardial infarction, four patients (22%) had diabetes mellitus, and nine (50%) had hypertension.

### The study protocol

Temporary epicardial pacing wires were intraoperatively placed both on the right ventricle (RV) and LV in all patients. The epicardial wires were placed on the RV to the outflow tract and on the LV to the apex. On the fifth postoperative day echocardiography was performed and tissue Doppler measurements taken during basal, RV pacing and LV pacing. During RV and LV pacing, the heart rate was increased above the basal rate. During the analysis, at least three cardiac cycles were recorded in the tissue velocity imaging (TVI) mode. The recorded images were analyzed by EchoPAC (EchoPAC 6.3, Vingmed-General Electric Healthcare). In the images that were collected for tissue synchronization LV septal and lateral segments were marked and were subsequently analyzed for delay in the septo-lateral segment.

### Conventional transthoracic echocardiographic TVI evaluation

Transthoracic echocardiographic studies were performed, with the patient in the left lateral position,

using GE Vingmed Vivid 5 system (Vingmed Ltd, General Electric Healthcare) in accordance with recommendations proposed by the American Society of Echocardiography.<sup>[7]</sup> Tissue Doppler sampled at the mitral and tricuspid annulus in the apical four-chamber view was used to derive peak tricuspid annular systolic velocity.

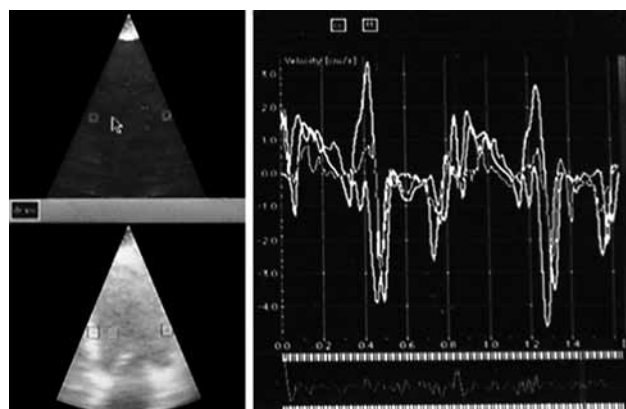
Color-coded tissue Doppler cine loops were obtained as routinely performed in our echocardiography laboratory from three beats obtained in the apical four-chamber view at the depths of  $14 \pm 2$  cm with pulse repetition frequency set at 1 kHz, Nyquist velocity range  $\pm 16$  cm/second and frame rates  $99 \pm 9$  Hz. Initial length for longitudinal strain assessment was set at 12 mm and regions of interest ( $20 \pm 2$  mm by  $7 \pm 1$  mm) were placed in the basal segments of the interventricular septum, and left ventricular lateral wall (Fig. 1). Left ventricular lateral wall dyssynchrony was determined as the difference in time to peak strain between the left ventricular lateral wall and the septum.

### Statistical analysis

The statistical analysis was performed using the SPSS for Windows version 11.0 (SPSS Inc., Chicago, Illinois, USA). The results were shown in mean  $\pm$  standard deviation and differences between two pacing sites were assessed using the Wilcoxon signed rank test. A  $p < 0.05$  was considered statistically significant.

## RESULTS

In all patients, during RV pacing significant intraventricular delay was documented between the septum and the lateral wall ( $52.94 \pm 20.71$  ms versus  $20.61 \pm 14.63$  ms;  $p < 0.001$ ). During LV pacing in all patients intraventricular delay was measured shorter than the basal value ( $12.72 \pm 12.08$  ms versus  $20.61 \pm 14.63$  ms;  $p = 0.001$ ) (Table 1). No complications were observed in all patients during the placement of intraoperative pacing wires,



**Fig. 1.** The color-coded tissue Doppler image belongs to one patient.

**Table 1. During right ventricle pacing significant intraventricular delay was documented between the septum and the lateral wall. During left ventricle pacing intraventricular delay was measured shorter than the basal value in all patients**

Patient number	Basal septo-lateral delay (msn)	RV pacing septo-lateral delay (msn)	LV pacing septo-lateral delay (msn)
1	42	61	30
2	0	51	0
3	0	48	0
4	37	58	31
5	31	40	4
6	33	60	23
7	30	40	11
8	42	70	39
9	32	57	25
10	8	22	5
11	18	83	9
12	5	66	5
13	20	86	20
14	12	58	4
15	10	21	7
16	10	70	8
17	35	54	8
18	6	8	0

RV: Right ventricle; LV: Left ventricle.

in the postoperative period when asynchrony measurements were performed and after the removal of the wires. There was no increase in the drainage volumes. Six patients were excluded from the study because of nonfunctioning RV pacing wires. There were no significant problems in the wires that were placed in the left ventricle.

## DISCUSSION

In open heart surgery, there is a need for pacemaker postoperatively in 2 to 4% of patients.<sup>[8,9]</sup> In coronary artery bypass grafting surgery this need is around 4%.<sup>[10]</sup> In patients that require repetitive surgeries this percentage increases up to 10%.<sup>[11]</sup> During the use of pacemakers the ventricles are stimulated from a different pathway and the different electrophysiologic characteristics of the structures that form the cardiac system there is a production of nonphysiologic impulse by the generation of pacemaker stimulus. This abnormal activation pattern causes a contraction that is non-homogenous in the LV, defects in the myocardial perfusion, increase in the sympathetic activation, fibrosis, and as a result of all of these changes a reconstruction occurs in the conduction system of the heart. The effects of RV pacing has been investigated in studies that evaluate the middle and long term effects of this pacing and showed that there are changes in the ejection fractions of the patient's hearts. These changes

have been attributed to the abnormal stimulation of the ventricles that causes interventricular and intraventricular asynchronous activities. Due to the asynchrony there are nonsimultaneous contractions in the myocardial walls that result in entrapment of the volume in the contracted ventricle, not enough increase in ventricular pressure and unsuccessful myocardial contraction that does not provide adequate volume. All these events cause deterioration in ventricular global functions. The regions that are activated early are predisposed to a decrease in their myocardial wall thickness whereas the regions that are activated late are observed to develop hypertrophy.

During normal LV activation LV segments contract simultaneously.<sup>[12]</sup> All the ventricular segments must contract in a time period of up to 40 ms. If the segments do not contract simultaneously than the LV systolic performance deteriorates because of the asynchronous movements. The segments that contract late cause an increase in wall tension of the early contracted segments, an increase in end systolic pressure and a decrease in relaxation. While the regions that contract early cannot provide pressure to start an ejection; the regions that contract late due to an increase in pressure earlier, contract against this increased pressure and this event causes a paradoxical increase in tension in the regions that have already completed their contraction. A delay in LV lateral wall activation and a delay in the

posteromedial papillary muscle contraction contribute to the development of mitral insufficiency.

Breithardt et al.<sup>[13]</sup> found that the delay in the septum lateral wall is an important predictor of the interventricular asynchrony in echocardiographic evaluations. By the use of the tissue Doppler echocardiographic studies, different myocardial segment peak systolic or diastolic velocities are determined as compared to the beginning of the QRS. The evaluation of asynchrony is based on the time difference between the peak myocardial velocities. The time difference between the two different segment velocities are measured in ms and the values that are calculated are used to demonstrate the asynchrony. The difference between the earliest and the latest peak velocities must be greater than 60 ms to be considered as asynchrony.

The RV pacing has disadvantages that it may cause LV dysfunction that can not be converted. Right ventricular apical pacing may especially cause different levels of preload in different myocardial segments. Compared to the segment that is further away from the place that is paced there is less use of oxygen and glucose and the result is the formation of weaker contractions. In the studies of DAVID (dual chamber and VVI implantable defibrillator) and MADIT II (multicenter automatic defibrillator implantation trial) in patients having chronic RV pacing there is a detection of more cases of new or worsened heart failure, increase in hospitalization secondary to heart failure and death.<sup>[14,15]</sup> Chronic RV pacing causes LV wall tension, distraction in homogeneity of the myocardium, disorganization of the myocardial fibers, and all these result in injury of the LV myocardial cells.<sup>[16-19]</sup> Inferolateral myocardial perfusion defect due to right ventricular pacing have been reported.<sup>[20]</sup>

The results of Blanc et al.<sup>[21]</sup> are similar to our findings. A delay in intraventricular conduction is observed in 27 patients and if patients received LV pacing or biventricular pacing the return of the acute hemodynamic parameters to basal values was statistically significant when compared to the patients that received RV pacing that showed no significant improvement.<sup>[22]</sup>

In our study the main finding is the demonstration of the intraventricular delay between the septum and the lateral wall compared to the basal values during RV pacing. Contrary to this finding, all patients who had LV pacing had shorter intraventricular delay values compared to the basal values. As a result of all of these observations, in patients with possible need for a pacemaker in the postoperative period, the temporary pacing wires should be placed on the LV.

#### Declaration of conflicting interests

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