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# SOME EARLY PREDICTORS OF A RECURRENCE OF FIBRILLATION OF AURICLES IN PATIENTS WHO HAVE UNDERGONE RFA OPERATION

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## SUMMARY

The aim of this study was to identify possible ECG predictors of atrial fibrillation (AF) recurrence in the early period after radiofrequency catheter ablation (RCA). We compare P-waves parameters before and after radiofrequency catheter ablation. In total 12 lead surface ECG of forty-two patients with paroxysmal and persistent atrial fibrillation were analyzed before and after catheter ablation. The 12 lead surface ECG was recorded on sinus rhythm before and within 24-48 h after RCA. 13 patients out of 42 had atrial fibrillation recurrence. Patients with early AF recurrence

were significantly older than patients with sinus rhythm. In the group of patients with AF recurrence, the duration of P wave was longer than in the group without AF recurrence. After RCA in both groups there were observed reducing of PQ interval and increasing of heart rate.

**Key words:** *surface 12 lead ECG, R-wave, atrial fibrillation (AF), predictors of AF recurrence, radiofrequency catheter ablation.*

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## INTRODUCTION

Atrial fibrillation (AF) is the most common sustained cardiac rhythm disorder and major cause of morbidity and mortality.

AF is the most common arrhythmia in adults. Its frequency composes 1-2% in overall population. In the United States, 5.2 million suffer from AF, and more than 6 million in Europe. In addition, in some cases, AF stays unidentified, and about one third

of patients are asymptomatic and unaware of existence of AF [1].

The main complication of AF is cardiogenic thrombembolia that increases the risk of stroke in 4-5 times. Approximately 15% of all ischemic strokes are caused by AF with the increase to 24% at the age of 80-89 years.

The USA spend about \$ 8,700 for the patient with AF per year, which amounts to 16 – 26 billion US dollars annually [2, 3, 4]. In connection with this, the main strategy of primary prevention

of AF is to identify patients at high risk of AF among the overall population. This group of people includes elderly patients, females, cardiac diseases and associated conductions.

The diagnostic possibilities of 12 lead surface ECG as predictor of AF recurrence was shown in different reviews [5].

Despite a wide range of contraindications for the catheter ablation there was shown the prevalence of catheter ablation versus antiarrhythmic therapy of AF [6].

However, it is known that RFA is not always successful and 25-30% of patients who have undergone RCA have AF recurrence. Therefore, it is important to determine the predictors of early AF recurrence in this period.

According to the study [7], hemodynamic, clinical, electrocardiographic and echocardiographic parameters (for example, the degree of aortic and mitral regurgitation, diameter of the LP), the technical features of the operation (the number of RFA applications, the type of RFA, the number of reference points) may be used to identify AF recurrence predictors. In the study of Okumura Y. et al. and Caldwell, J. et al. as the marker of the positive prognosis of the transferred RFA, the length of the P wave was determined [8, 9].

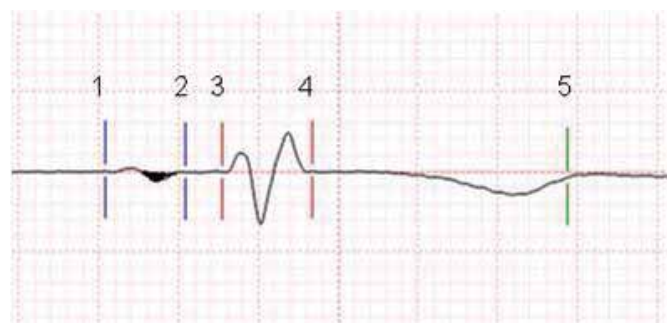
Kizilirmak F. et al. also concluded that a decrease in the duration and amplitude of the P wave is indicative of a good clinical outcome after RFA [10].

## MATERIAL AND METHODS

We reviewed the records of 12 lead surfaces ECG of forty-two patients ( $61.0 \pm 11.0$  years) with paroxysmal and persistent AF. The 12 lead surface ECG was recorded by ATEC system, Russia. All studied patients had 12 lead ECGs demonstrating sinus rhythm performed both prior to and within 24-48 hours after RCA, including once for 3 months after RFA.

P wave duration in the lead, P wave amplitude P in the lead P II, the P axis (Paxis), and the P terminal force as product of the amplitude and duration of the terminal negative part of the P wave in lead V1 were measured and examined. The P-Q interval and the heart rate (HR) were also analyzed. We compared P wave parameters in all our studied patients based on pre-ablation and post-ablation 12 lead ECGs.

The electrocardiographic characteristics of the P wave have shown in Figure 1.



**Figure 1. Interval PQ and parameters of the P wave.**

1-2 – duration of the P wave (Pd), 1-3 integer PQ (PQ d), 3-4 – duration of the QRS complex, 3-5 – duration of the QT. The negative phase of the P wave has been hatched. The amplitude of both phases (positive and negative) is determined in the P wave

## RESULTS

### ECG changes before and after RFA

The post catheter RFA ECG recorded 24-48 hours after the ablation, demonstrates the preserved sinus rhythm. AF recurrences were detected within 3 months after in 13 of 42 patients undergoing RFA. Changes in the parameters of the P wave, duration of PQ, and heart rate of two groups of patients were studied: groups of patients with a preserved sinus rhythm after RFA and a group with early recurrence of AF. The characteristics of the ECG parameters studied before (1) and after (2) the catheter RFA are presented in Table 1.

After surgery, there was a significant increase in heart rate ( $<0.03$ ), a decrease in the duration of the P wave from  $122 \pm 13.6$  ms to  $116 \pm 21.2$  in 32 patients ( $P \leq 0.03$ ), a decrease in the duration of the PQ interval ( $170.1 \pm 28.4$  ms to and  $165.2 \pm 26.8$  ms after RFA,  $P \leq 0.04$ ). The mean values of the axis of the P wave and the terminal index were within the normal range and did not change: MPaxis  $46.3 \pm 19.0$ , PTF  $0.052 \pm 0.046$  mm\*sec. The exception was 1 patient with P axis  $\leq 0^\circ$  and 4 patients with P axis  $\geq 70^\circ$ . The amplitude P in the second lead averaged  $1.2 \pm 0.48$  mm, only one patient had more than 2.5 mm.

**Table 1. The ECG-12 parameters studied before (1) and after (2) the catheter RFA**

	Number of patients	Average value ( $M \pm \delta$ )	Minimum	Maximum
age	42	<b><math>61 \pm 11</math></b>	34	83
HR 1	42	$60 \pm 9$	45	80
HR 2	42	$73 \pm 11$	48	93
P 1	42	$122 \pm 14$	82	154
P 2	42	$117 \pm 21$	46	154
<b>PQ 1</b>	<b>42</b>	<b><math>170 \pm 28</math></b>	<b>120</b>	<b>252</b>
PQ 2	42	$165 \pm 27$	114	260
Paxis 1	42	$46 \pm 19$	0	77
Paxis 2	42	$49 \pm 19$	3	90
PV1d 1	42	$84 \pm 34$	0	140
PV1d 2	42	$74 \pm 28$	0	154
PV1a 1	42	$99 \pm 23$	0	111
PV1a 2	42	$102 \pm 16$	0	111
PTF 1	42	$113 \pm 20$	0	133
PTF 2	42	$114 \pm 21$	0	136

*Note: Heart rate 1 – heart rate at the time of imaging before RFA, heart rate 2 – heart rate at the time of the shot after RFA, P 1 – the duration of the P wave at the time of ECG recording before RFA, P 2 – the duration of the P wave at the time of ECG recording after RFA, PQ 1 – duration of the PQ interval on the ECG to the RFA, PQ 2 – duration of the PQ interval on the ECG after the RFA, Paxis 1 – the direction of the axis of the P wave on the ECG to the RFA, Paxis 2 – the direction of the axis of the P wave on the ECG after the RFA, PV1d 1 – the duration of the P wave on the ECG to the RFA, PV1d 2 – the duration of the P wave on the ECG after the RFA, PV1a 1 – the amplitude of the P wave on the ECG to RFA, PV1a 2 – amplitude of the P wave on the ECG after RFA, PTF 1 – terminal index on the ECG to RFA, PTF 2 – terminal index on the ECG after RFA. The bold type indicates indicators for which the confidence factor  $p < 0.03$ .*

### ECG changes in patients with and without AF recurrence before and after RFA

Patients with AF recurrence were significantly ( $P \leq 0.002$ ) older ( $69.3 \pm 7.5$  years) than patients without relapses ( $57.4 \pm 10.4$ ).

In the group of patients with AF recurrence, the duration of the P wave to RFA was longer, reaching a pathological level ( $125.0 \pm 33.6$  ms) than in the group without AF recurrence ( $120.3 \pm 11.6$  ms),  $P \leq 0.03$ . The Figure 2 (a, b) represents examples of ECG patients with AF recurrence and without AF recurrence. In a patient with an AF recurrence, the initial duration of the P wave was 162 ms, PQ – 196 ms, significantly exceeding these indices in the patient without AF recurrence.

In both groups there was observed reduction of the PQ interval after the RFA (3a, b). The Fig. 3 (a, b) shows an example of a change in PQ in a patient with a relapse before and after an RFA operation. In this patient, the initial duration of the PQ wave was 192 ms and decreased after RFA to 154 ms.

It should be noted that the initial duration of the PQ interval was significantly ( $P \leq 0.02$ ) more in patients with relapsed AF than in patients without relapses (see Table No. 2). The noted features were not affected even by the initially increased duration of PQ  $\geq 204$  ms, which was detected in 6 patients before the operation.

Calculation of average indices, including cases with initial atrioventricular blockade of 1 st., and without these cases, did not affect the trend of dynamics of the average values of PQ after the operation. The duration of the PQ interval before the operation did not have a significant effect on the development of early AF recurrence, as only 3 patients with initially increased PQ interval had relapses of AF.

### DISCUSSIONS

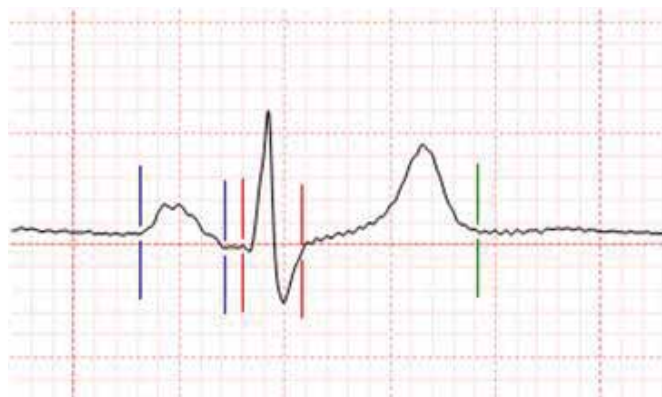
Our study shows that the age of patients with the development of early relapses of AF who underwent the RFA is significantly older than patients without AF recurrence.

Coronary heart disease and the formation of cardiosclerosis, arterial hypertension, leading to ventricular and atrial remodeling and, as a result, electrophysiological, mechanical and morphological restructuring of the myocardium [11], may explain the high probability of AF recurrence in the patients of older group.

The frequency early AF recurrence and their significance in the final conclusion about the restoration of the rhythm of the heart have not been sufficiently studied. Published data characterizing the first 3 months after the RFA, the so-called. "Blind period" is few. However, in a study by Bertaglia et al., it was shown that 40% of recurrence of supraventricular tachyarrhythmias occur within the first three months after RFA, with a large proportion occurring in the first week after RFA [12].

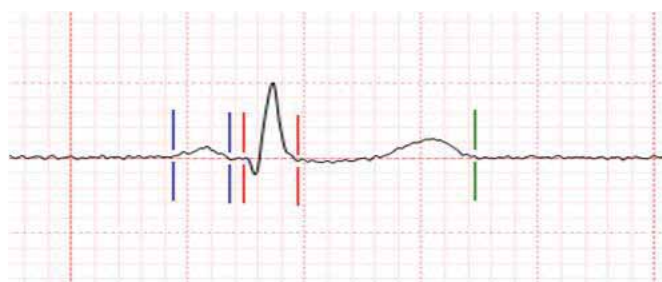
Similar data are given in [13], which indicates that the peak of early AF recurrence occurs in the first few weeks after invasive intervention and decreases by the end of a three-month follow-up, and the absence of AF during the first weeks after RFA has a positive prognostic value in remote observation period.

Early recurrence may be related to the period of rehabilitation after RFA surgery. During the initial rehabilitation – from several hours and up to 3-5 days after the surgery – the probability of recurrence of AF is high, as the frequent complication after RFA. Complications in the form of a AF recurrence may be triggered, possibly, as a mechanical trauma of the pulmonary veins with the development of inflammatory and sclerotic changes, and concomitant pathology (CHD, elderly age, female gender, prolonged anamnesis), which complicates the rehabilitation period.



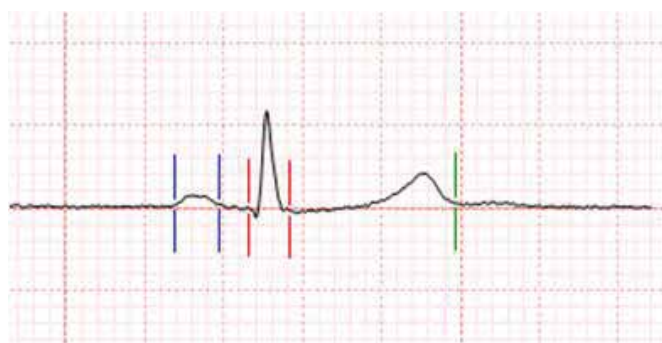
**Figure 2, a. Patient with early AF recurrence, before RFA**

*HR – 59 beats/min, P – 162 ms, PQ – 196 ms, mV=10 mm, V=25 mm/s*



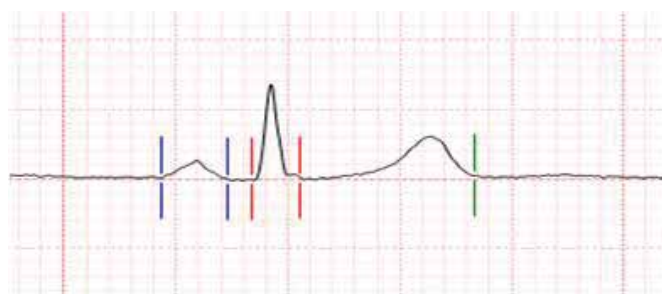
**Figure 2, b. Patient without AF recurrence, before RFA**

*HR – 64 beats / min, P – 94 ms, PQ – 120 ms, mV=10 mm, V=25 mm/s*



**Figure 3, a. With early AF recurrence, before RFA**

*PQ – 192 ms, mV=10 mm, V=25 mm/s*



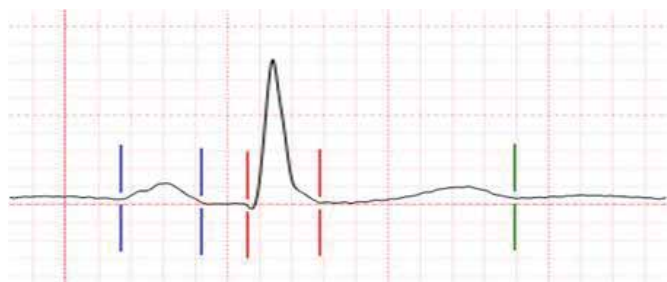
**Figure 3, b. The same patient, after the RFA**

*PQ – 154 ms, mV=10 mm, V=25 mm/s*

In the period of early rehabilitation, the presence of repeated RFA in the anamnesis may adversely affect and induce recurrence of AF.

When studying the characteristics of the P wave and duration of PQ, it was shown that patients without AF recurrence have normal

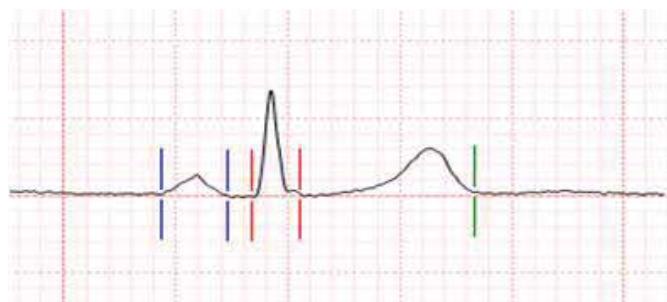




**Figure 4, a. Without AF recurrence, before RFA**

PQ – 158 ms

mV=10 mm, V=25 mm/s



**Figure 4, b. The same patient after RFQ**

PQ – 150 ms

mV=10 mm, V=25 mm/s

**Table 2. Comparative characteristics of ECG parameters in patients with early relapses of AF (+) after and without catheter RFA (-)**

	AF (-)	AF (+)	p	AF (-) quantity	AF (+) quantity
age	57±10	69± 7	0,000663	29	13
HR 1	61±8	60±12	0,839497	29	13
HR 2	73±9	71±14	0,505863	29	13
P1	120±12	125±17	0,306668	29	13
P2	118±13	115±34	0,682190	29	13
PQ1	164±29	184±23	0,033145	29	13
PQ2	161±25	174±29	0,138049	29	13
Paxis1	46±19	46±20	0,949940	29	13
Paxis2	48±18	51±21	0,646189	29	13
PV1d1	84±35	85±34	0,925641	29	13
PV1d2	74±23	74±38	0,971124	29	13
PV1a1	100±19	97±29	0,613985	29	13
PV1a2	104±3	97±29	0,202781	29	13
PTF1	115±8	109±35	0,442801	29	13
PTF2	112±8	119±36	0,387159	29	13

Note: AF (-) patients without recurrence of atrial fibrillation, AF (+) patients with recurrence of atrial fibrillation, p-heart rate 1 – heart rate to RFA, heart rate 2 – heart rate in RFA, P 1 – duration of P wave to RFA, P 2 – duration of the tooth P after the RFA, PQ 1 – duration of the interval PQ to the RFA, PQ 2 – duration of the interval PQ after the RFA, Paxis 1 – axis of the P wave before the RFA, Paxis 2 – axis of the P wave after the RFA, PV1d 1 – duration tooth P to RFA, PV1d 2 – the duration of the tooth P after the RFA, PV1a 1 – amplitude of the tooth P to the RFA, PV1a 2 – amplitude of the tooth P after the RFA, PTF 1 – terminal index to RFA, PTF 2 – terminal index after RFA.

rhythm-dependent changes in P and PQ. In patients with AF recurrence, the duration of the P wave on the electrocardiogram before the operation reached pathological values and was greater than in patients without AF recurrence. The initial duration of the PQ interval was also greater in patients with recurrence in patients without AF recurrence.

Nielsen JB, et al. when analyzing the data of 288181 persons with an average follow-up period of 5.7 years, they found that for women the initial values of the PQ interval were 196 ms and more, and for men PQ=204 ms or more were associated with an increased risk of AF development [14]. In our work, there was no gender division of the surveyed, but in the general group of men and women the baseline PQ values for recurrence were also greater than in the absence of AF recurrence.

The data obtained by us coincide with the studies of Maan A, et al. [15], in which, in the study of early AF recurrence before and after catheter ablation in 46 patients with AF with successfully performed RFA, a significant decrease in the duration of the P wave was observed. According to the researchers, these changes are associated with a decrease in the volume of electrically active atrial tissue after ablation, denervation of the vagus, and a change in the course of electric excitation at the atria.

In addition, a decrease in the terminal index in leads V1 and aVF, noted by Janin S. et al. [16] and in our study, is associated with the size of the left atrium. Depolarization of the posterior wall of the left atrium, reflecting the terminal portion of the P wave, is used as a marker for the success of ablation.

## CONCLUSIONS

1. The operation of RFA in patients with paroxysmal and persistent forms of AF affects the duration of the P wave – it decreases.

2. Before RCA in patients with AF recurrence, the duration of the P wave and the duration of PQ were significantly greater than in patients without early AF recurrence, which may allow using these parameters as an early predictor of atrial fibrillation after the pulmonary vein isolation.

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