JEURMEDS Journal of Eurasian Medical Science

Original Article

Jeurmeds 2022;3(1):1-5 • **DOI:** 10.5578/jeurmeds.20220102

The Effect of RCA Morphology on Predicting Atrial Fibrillation Risk

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Cite this article as: Coşkun M, Tatar S, Özer SF, Özçelik A, Özcan Abacıoğlu Ö, Alsancak Y. The effect of RCA morphology on predicting atrial fibrillation risk. JEURMEDS 2022;3(1):1-5.

ABSTRACT

Objective: Right coronary artery (RCA) has two anatomical variations detected on coronary angiography, namely C-shaped and sigma shaped RCA. It is known that C shaped coronary artery is associated with more atherosclerotic disease, but there are no studies showing whether there is a difference between these variations in terms of susceptibility to atrial fibrillation. The aim of this study was to determine if there is an increased risk in one of these variations or not.

Material and Methods: A total of 124 participants with normal coronary arteries in coronary angiography were included in our study. Fifty-six had sigma shaped (45%) and 68 had C shaped right coronary artery. P maximum (p max), p minimum (p min), p wave dispersion and p terminal force were calculated from electrocardiography. 24 hour holter monitoring was performed for detecting any arrhythmias.

Results: We determined prolonged p max, p min, p wave dispersion (PD) in sigma shaped right coronary artery in patients and also abnormal p terminal force in 62% of those. There was a statistically significant difference between all electrocardiographic parameters. In C shaped coronary artery group, two of the patients had paroxsymal atrial fibrillation in holter monitoring while 8 had paroxsymal atrial fibrillation in the Sigma shaped group (p= 0.021).

Conclusion: Right coronary artery morphology can be used to determine the risk of atrial fibrillation.

Keywords: RCA shape, atrial fibrilation, sigma RCA

ÖZ

Atriyal Fibrilasyon Riskini Öngörmede RCA Morfolojisinin Etkisi

Giriş: Sağ koroner arterin (RCA), koroner anjiyografide saptanan C şekilli ve sigma şekilli RCA olmak üzere iki anatomik varyasyonu vardır. C şeklindeki koroner arterin daha çok aterosklerotik hastalık ile ilişkili olduğu bilinmektedir ancak bu varyasyonlar arasında atriyal fibrilasyona yatkınlık açısından bir fark olup olmadığını gösteren bir çalışma bulunmamaktadır. Bu çalışmanın amacı, bu varyasyonlardan herhangi birinde risk artışı olup olmadığını belirlemektir.

Gereç ve Yöntemler: Koroner anjiyografide koroner arterleri normal olan toplam 124 katılımcı çalışmamıza dahil edildi. Elli altısı sigma (%45) ve 68'i C şeklinde sağ koroner artere sahipti. Elektrokardiyografiden P maksimum (p max), p minimum (p min), p dalga dağılımı ve p terminal kuvveti hesaplandı. Herhangi bir aritmi tespiti için 24 saat holter monitorizasyonu yapıldı.

Bulgular: Sigma şekilli sağ koroner arter hastalarında uzamış p max, p min, p dalga dispersiyonu (PD) ve bunların %62'sinde anormal p terminal kuvveti saptadık. Tüm elektrokardiyografik parametreler arasında istatistiksel olarak anlamlı bir fark vardı. C tipi koroner arter Grup 2'de hastaların holter monitörizasyonunda paroksimal atriyal fibrilasyon, sigma koroner arterlerde ise 8'inde (p= 0.021) mevcuttu.

Sonuç: Atriyal fibrilasyon riskini belirlemek için sağ koroner arter morfolojisi kullanılabilir.

Anahtar Kelimeler: RCA şekli, atrial fibrilasyon, sigma RCA

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Received: 29.11.2021
Accepted: 12.12.2021
Available Online Date: 24.06.2022

INTRODUCTION

Atrial fibrillation is an irregular and often rapid heart rate that can increase the risk of stroke, heart failure and other heart-related complications. It is seen in 1-2% of the general population and is the most common continuous cardiac arrhythmia (1). During atrial fibrillation, the heart's two upper chambers beat chaotically and irregularly, out of coordination with the two lower chambers of the heart. Atrial fibrillation symptoms often include heart palpitations, shortness of breath and weakness.

Age, hypertension, heart failure, heart valve diseases, congenital heart diseases, atherosclerosis, obesity, diabetes mellitus, chronic obstructive lung disease, sleep apnea can be predisposing factors for atrial fibrillation (2).

Twelve lead electrocardiogram and holter monitoring are used for diagnosis and follow up. P wave dispersion is a noninvasive electrocardiographic marker for atrial remodeling and predictor for atrial fibrillation. P terminal force in lead V1 of a Standard 12-lead electrocardiogram was first introduced by Morris et al. and abnormal values were associated with increased mortality and high risk of AF (3).

Several researchers have suggested that hemodynamic stresses related to arterial geometry and anatomic variations in the arterial wall may predispose the vasculature to atherosclerosis in their vicinity through their effect on the local flow field (4). Previous studies have reported that RCA length, curvature, shape and flow patterns are predisposed to atherosclerosis (5). However, it has not been examined whether there is an association between the shape of RCA and the risk of atrial fibrillation. The purpose of our study was to investigate this issue.

MATERIALS and METHODS

Study Population

The study included 124 patients (aged 33-84 years) who underwent coronary angiography and had no lesions. Subjects were excluded if they had dilated heart disease, important valvular disease, coronary slow flow, ectasia or lesions, left ventricular hypertrophy, use of beta blockers or calcium channel blockers or any drugs that could influence the conduction time of heart. The patients were divided into two groups according to the shape of RCA. Group 1 consisted of 68 patients with C-shaped RCA and Group 2 consisted of 56 patients with sigma- shaped RCA.

Coronary Angiography

All patients were catheterized percutaneously via the femoral artery, with the Standard Judkins technique. In order to determine the shape of RCA, we used the left anterior oblique projection at 25-35° usually with no craniocaudal angulation. A line was drawn between each of the two consecutive most lateral points on the side of the arteries and the longest of the perpendicular widths between that line and artery was chosen and measured as the curve width. Arteries whose curve width was longer than the distance between two consecutive most lateral points of the measured curve were categorized as sigma shaped, and arteries that had only one lateral point or did not fulfill the criteria for a sigma shape or curled were categorized as C-shaped (6).

Electrocardiography

Every patient underwent a resting 12 lead electrocardiogram recorded at a paper speed of 50 ms and voltage of 1 mV. We calculated p maximum and p minimum from the surface ECG. P dispersion (based on the difference between maximum and minimum P wave duration) was calculated based on patient's ECG. Increased P wave duration and PD reflect prolongation of intra-atrial and interatrial conduction time with lack of a well-coordinated conduction system within the atrial muscles. All standard ECGs were obtained in a quiet room with the same recorder. P terminal force in lead V1 was defined as the duration in seconds of the terminal (negative) part of the p wave multiplied by its dept in millimeters (Figure 1). Abnormal PTFV1 was defined as PTFV1> 0.06 mm.s and is a strong indicator of enlarged, poorly functioning LA and associated with increased risk of AF (7). Wave measurement were conducted blindly by a trained cardiologist.

24h Holter Monitoring

A Holter monitor is a medical device that records the heartbeat and checks for unusual signs. It may be ordered for 12, 24, or 48 hours, depending on the symptoms and how often they occur. In our study, 24-hour holter monitoring was used, and the results were assessed by the same cardiologist.

Statistical Analysis

Statistical analyses were performed using SPSS statistical software package (version 17, SPSS, Chicago, IL, USA). The

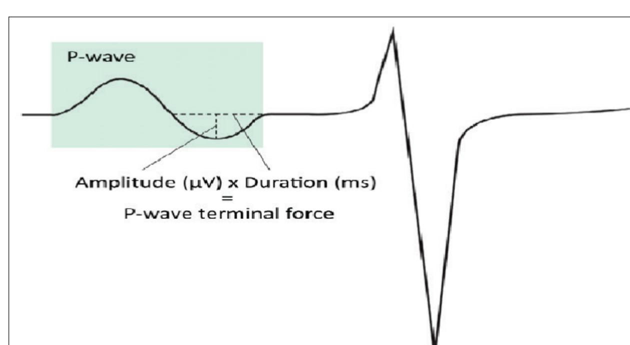

Figure 1. Calculation of p terminal force.

continuous variables were expressed as mean ± standard deviation. Comparison of the continuous variables between the groups were performed using the independent samples t-test as appropriate. Categorical variables were compared by Chi-square test. Correlations between variables were performed using the Pearson product moment and multivariate analysis was performed to estimate the potential influence of variables on the p wave dispersion and p terminal force. A p value less than 0.05 was considered as significant.

RESULTS

Baseline demographic and clinical characteristics of study groups are shown in Table 1. The groups were only different in terms of hyperlipidemia.

Electrocardiographic findings of the groups are shown in Table 2. P wave duration, both p maximum and p minimum, was significantly longer in sigma-shaped RCA group and the difference between groups was statistically significant ($p< 0.001$ and $p= 0.009$, respectively). As a result of longer periods of p wave measurements, p wave dispersion was calculated higher in this group too (Figure 2).

Abnormal p terminal force was found in 62% of the sigma shaped RCA group and in 14% of the other group. P value was <0.001.

In multivariate analysis, considering the comorbid status of the patients, only RCA shape was found to be the determinant for p wave dispersion ($p< 0.01$, $\eta_p^2= 0.595$). While diabetes mellitus and RCA shape are determinative for p terminal force, it is possible to say that RCA shape with higher partial eta squared levels has more effect ($p= 0.019$, $\eta_p^2= 0.044$ and $p< 0.001$, $\eta_p^2= 0.263$ respectively).

Table 1. Baseline demographics and clinical characteristics of the groups, and statistical analysis

	C shaped RCA (n= 68)	Sigma shaped RCA (n= 56)	p
Age (mean ± SD)	59.54 ± 11.94	60.91 ± 13.41	0.550
Sex			
Male (n)	28	39	
Female (n)	40	17	
HT			
Yes (n)	30	23	0.733
No (n)	38	33	
DM			
Yes (n)	20	9	0.081
No (n)	48	47	
HL			
Yes (n)	24	9	0.016
No (n)	44	47	
Smoking			
Yes (n)	21	22	0.328
No (n)	47	34	
Family history			
Yes (n)	37	22	0.093
No (n)	31	34	

Table 2. Electrocardiographic findings of the groups, and statistical analysis

	C shaped RCA (mean ± SD)	Sigma shaped RCA (mean ± SD)	p
p max	105.67 ± 12.69	120.98 ± 11.86	<0.001
p min	86.00 ± 13.45	91.57 ± 8.75	0.009
p wave dispersion	19.05 ± 8.89	29.41 ± 7.21	<0.001
p terminal force			
Abnormal n (%)	10 (14%)	35 (62%)	<0.001
Normal n (%)	58 (86%)	21 (38%)	

Table 3. The effect of comorbid status on p wave dispersion and p terminal force, p value and partial eta squared levels

	P wave dispersion (p and η_p^2)	P terminal force (p and η_p^2)
Age	0.932-0.118	0.171-0.150
Family history	0.249-0.219	0.064-0.028
HT	0.296-0.211	0.942-<0.001
DM	0.404-0.196	0.019-0.044
HL	0.260-0.217	0.470-0.004
Smoking	0.706-0.158	0.772-0.001
RCA shape	<0.001-0.595	<0.001-0.263

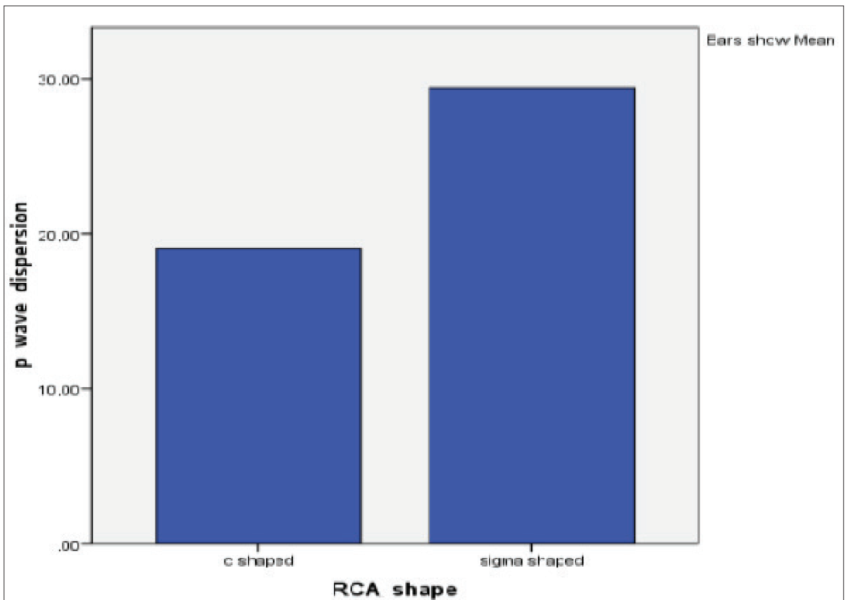

Figure 2. P wave dispersion according to RCA shape.

Paroxysmal atrial fibrillation was detected in two patients in the C shaped RCA group (3%) and in eight patients in the shaped RCA group (14%) with 24-hour holter monitoring. The difference was significant in two groups (p= 0.021).

DISCUSSION

The main findings of this study were

1. p wave dispersion and p terminal force might be affected from many comorbid status, shape of coronary artery was one of those.
2. In sigma shaped RCA p wave dispersion was longer and p terminal force was more abnormal than in C-shaped.
3. Sigma-shaped RCA may have increased risk for atrial fibrillation.

Maximum p wave duration and p wave dispersion detected from electrocardiography are non-invasive markers that show unstable distribution of the excitations from the sinus node and used as a marker to predict atrial fibrillation risk. Age, left atrial dimension, pump function, diastolic and systolic functions have been reported to be associated with p wave dispersion. In many studies, the relationship between p wave dispersion and clinical conditions have been investigated. Dilaveris et al. have shown that p wave dispersion could be evaluated as an indicator of idiopathic atrial fibrillation (8). Szabo et al. have found that p wave dispersion was increased in hemodialysis patients in their study (9). As shown in the examples above, p wave dispersion is affected in many cases effecting cardiac functions and therefore, it may be a useful parameter in predicting cardiac pathologies. In our study, we did not find any correlation between comorbidities and p wave dispersion, except RCA shape. It was shown in our study that RCA shape was determinative for PD, and sigma-shaped RCA also had increased p wave dispersion compared to the C-shaped.

P terminal force has proven to be a specific indicator of left atrial enlargement and correlates with left heart filling pressures in the presence of various cardiac pathologies. Subjects presenting PTF≥ 0.04 mm.s seem to be at increased risk for death, cardiac death, and congestive heart failure, and subjects presenting PTF≥ 0.06 mm.s also seem to be at increased risk for atrial fibrillation. The report by Martin Garcia et al. gives more evidence that abnormal PTFV1 is independent of the size of left atrium, a predictor as AF recurrence (10). Tanoue et al. have found that abnormal PTFV1 is associated with worse diastolic function and predicts abnormal LV diastolic behavior in patients with preserved EF after three years of blood pressure reductive therapy (11). Diabetes mellitus and RCA shape were associated with abnormal PTFV1 in present study. The shape of RCA was more effective, and especially in sigma shaped RCA, the number of abnormal values were higher.

Study Limitations

This study had a small population group and was a single center study. Furthemore, we used 24-hour holter monitoring so if the period had been longer, the results could have been different.

CONCLUSION

P terminal force and p wave dispersion are simple ECG indicators that can be used to determine the risk of atrial fibrillation. Although it is known that the risk and progression of atherosclerosis may be different according to the change in right coronary artery morphology, no studies have been conducted related to atrial fibrillation and right coronary artery morphology. In this study, p wave dispersion and p terminal force were found to be significantly higher in sigma-shaped RCA. These patients should be followed and informed about this issue, and necessary examinations should be done.

Ethics Committee Approval: This study was approved by the Adana City Training and Research Hospital Clinic Research Ethics Committee (Decision Number: 498, Date: 24.07.2019).

Author Contributions: Concept/Design: MC, ST, AÖ; Analysis/Interpretation: YA, MC, ÖÖA, AÖ; Data Acquisition: SFÖ, ST, MC, ÖÖA; Writting: MC, ÖÖA; Critical Revision: ST, MC, YA; Final Approval: YA, SFÖ, MC.

Conflict of Interest: There is no conflict of interest.

Financial Disclosure: The authors declared that this study has received no financial support.

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