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Original Article

The relationship between coronary arterial dominance and the QRS axis

Koroner arteriyel baskınlık ve QRS ekseni arasındaki ilişki

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ABSTRACT

Aim: Coronary artery dominance influences the amount and anatomic location of myocardium that is perfused by the left or right coronary circulation. However, the association between coronary arterial dominance and the QRS axis on 12-lead surface electrocardiography (ECG) was not investigated. The present study aims to evaluate the relationship between coronary arterial dominance and the QRS axis on ECG in patients without significant coronary artery and structural cardiac disease.

Material and Methods: Overall, 133 patients, without significant CAD and who met the inclusion criteria, participated in this study. A standard surface 12-lead ECGs were performed in all study patients. QT interval, QTc interval, QRS duration, PR interval, P wave and QRS axis were determined. Based on the origin of the posterior descending coronary artery, coronary circulation was categorised into left, right, and balanced coronary dominance.

Results: There were 133 subjects with 56 right dominant (42%), 39 left dominant (29%) and 38 codominant (29%) pattern. QRS axis value was found to be significantly higher in the left dominant group when compared with the codominant and right dominant group ($p<0.05$). No significant difference was observed between the codominant and right dominant groups regarding QRS axis values. The axis of (+30)-(+90) ratio in the left dominant group was found to be significantly higher when compared with the codominant and right dominant group ($p<0.05$). No significant difference was observed between the codominant and right dominant groups regarding the axis of (+30)-(+90) ratio.

Conclusion: Our findings suggested that the QRS axis may be related to coronary artery dominance.

Keywords: coronary artery dominance; QRS axis

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ÖZ

Amaç: Koroner arter baskınlığı, sol veya sağ koroner dolaşım tarafından perfüze edilen miyokardın miktarını ve anatomik konumunu etkiler. Ancak, koroner arter baskınlığı ile 12-lead yüzey elektrokardiyografisindeki (EKG) QRS ekseni arasındaki ilişki araştırılmamıştır. Bu çalışma, ciddi koroner arter ve yapısal kardiyak hastalığı olmayan hastalarda koroner arter baskınlığı ile yüzey EKG' deki QRS ekseni arasındaki ilişkiyi değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntemler: Ciddi koroner arter hastalığı olmayan ve dahil etme kriterlerini karşılayan tam olarak 133 hasta bu çalışmaya katılmıştır. Tüm çalışma hastalarında standart yüzey 12-lead EKG çekildi. QT aralığı, QTc aralığı, QRS süresi, PR aralığı, P dalgası ve QRS ekseni belirlendi. Posterior inen koroner arterin kökenine göre koroner dolaşım, sağ, sol ve dengeli (kodominant) koroner dominant olarak sınıflandırıldı.

Bulgular: 56 sağ dominant (% 42), 39 sol dominant (% 29) ve 38 kodominant (% 29) paternli 133 hasta vardı. Kodominant ve sağ dominant grup ile karşılaştırıldığında, QRS ekseni değeri sol dominant grupta anlamlı olarak daha yüksek bulundu ($p<0.05$). Kodominant ve sağ dominant gruplar arasında QRS ekseni değerleri açısından anlamlı fark saptanmadı. Sol dominant grupta QRS ekseni (+30) - (+ 90) oranı, kodominant ve sağ dominant grup ile karşılaştırıldığında anlamlı derecede yüksek olduğu bulundu ($p<0.05$). Kodominant ve sağ dominant gruplar arasında QRS ekseni (+30) - (+ 90) oranları arasında anlamlı bir fark gözlenmedi.

Sonuç: Bulgularımız QRS ekseninin koroner arter baskınlığı ile ilişkili olabileceğini düşündürmektedir.

Anahtar kelimeler: koroner arter baskınlığı; QRS ekseni

Introduction

Anatomical coronary dominance is defined by the origin of the posterior descending artery (PDA), which supplies the posterior portion of the interventricular septum. In a right-dominant (RD) circulation, the right coronary artery (RCA) gives off the PDA, while in a left-dominant (LD) circulation the left circumflex (LCX) artery supplies this territory. In a codominant circulation, the supply of the posterior interventricular septum is shared by the RCA and LCX. RD is the most prevalent pattern of coronary circulation, which is found in 72–90% of individuals, while the prevalence of LD and balanced coronary dominance (BD) is reported to be 8–33% and 3–7%, respectively [1].

Studies have been conducted regarding the prognostic significance of coronary artery dominance in patients with CAD. A left dominant system has been shown to be an independent risk factor of morbidity and mortality in patients who underwent both surgical and percutaneous revascularization, particularly in patients with ST-segment elevated myocardial infarction (STEMI) [2-4]. In addition, LD is shown to be an independent predictor of increased all-cause death and MACE in patients with chronic total occlusion (CTO) [5]. Therefore, an assessment of coronary vessel dominance by angiography could contribute to risk stratification in patients with coronary artery disease. However, so far interaction of coronary arterial dominance and the QRS axis on 12-lead surface electrocardiography (ECG) was not investigated thoroughly. The present study aims to evaluate the relationship between coronary arterial dominance and the QRS axis on ECG in patients without significant coronary artery and structural cardiac disease.

Material and Methods

Patients with chest pain, or other signs and symptoms suggestive of CAD referred for elective coronary angiography were screened for the enrollment in this study. Overall, 133 patients, without significant CAD and who met the inclusion criteria, participated in this study.

Patients were excluded if they had known history of CAD, acute coronary syndrome, chronic kidney disease, advanced liver disease, cancer, infection, hyper-or hypothyroidism, left ventricular (LV) systolic dysfunction (LV ejection fraction <50%), or any congenital heart disease. In addition, patients with a history of myocardial infarction and/or left ventricular hypertrophy based on echocardiography and ECG findings were also excluded. Any rhythm disturbance other than sinus (including permanent pacemakers, atrial fibrillation; bundle branch block; and patients taking the class I or class

III antiarrhythmic drugs) were not included. Furthermore, the young, thin, elderly and obese population were excluded from this study due to normal variants right or left QRS axis deviation.

A standard surface 12-lead ECGs were performed in all study patients. QT interval, QTc interval, QRS duration, PR interval, P wave and QRS axis were determined. Despite the fact that a real consensus on the normal values of the QRS axis has not been made yet, values of -30 and +90° of QRS axis were accepted as normal based on recommendations of the ACC/AHA ECG guidelines published in 2009 [6]. The QRS axis is computed by the hexa-axial reference system. There are several different ways for determining the QRS axis. In addition to computer software, studies have also pointed out that there is a high correlation between the QRS axes computed by inspection, computer, or the vector method [7]. Thus, for practical purposes, computer software was chosen for this study.

Images of the coronary angiography were obtained using standardized angiographic projections according to the guidelines of the American College of Cardiology/American Heart Association and stored digitally [8]. All images were retrospectively reviewed for the coronary dominance by two experienced observers. The coronary artery system was classified as right dominant if the RCA, as left dominant if the LCX, or as balanced if the RCA and LCX gave rise to the PDA. Significant CAD was defined as ≥50% narrowing of the luminal diameter in at least one projection of at least one major epicardial artery and was excluded.

The local ethics committee approved the study protocol, and informed consent was obtained from all of the patients. Local ethics committee approved the study and informed consent was obtained from participant(s)

Statistical analysis

Data were analyzed using SPSS software version 22.0 for Windows (SPSS Inc, Chicago, IL, USA). The Kolmogorov-Smirnov test was used to test the normality of the distribution of the continuous variables. The continuous variables were presented as mean±standard deviation or as median and interquartile ranges, and categorical variables were given as counts and percentages. Categorical variables were compared with chi-square test. The Kruskal-Wallis and Mann-Whitney U tests were used to compare non-normally distributed parametric data. For all tests, a 2-tailed P<0.05 was considered significant.

Results

Baseline characteristics and electrocardiographic findings of the patient are listed in Table 1.

Table 1. Baseline characteristics of study patients

		Min-Max	Median	Mean.±s.d./n-%
Age,(years)		23.0-76.0	55.0	52.1±12.0
Sex	Female			69-51.9%
	Male			64-48.1%
Weight, (kg)		50.0-110.0	64.0	63.7±12.4
Height,(m)		1.5-1.9	1.6	1.6±0.1
BMI		20.3-29.8	25.2	25.7±3.0
HT	No			68-51.1%
	Yes			65-48.9%
DM	No			100-75.2%
				33-24.8%
Smoking	No			97-72.9%
	Yes			36-27.1%
P axis		-30.0-132.0	47.0	47.6±22.9
QRS axis		-25.0-85.0	22.0	28.2±28.3
T axis		-40.0-90.0	35.0	36.1±25.6
PR, (msn)		112.0-192.0	148.0	148.4±13.5
QT,(msn)		350.0-450.0	390.0	396.3±24.9
QRS axis		(-30)-(+30)		76-57.1%
		(+30)-(+90)		57-42.9%

BMI; body mass index, DM; diabetes mellitus, HT; hypertension, s.d; standard deviation

There were 133 subjects with 56 right dominant (42%), 39 left dominant (29%) and 38 codominant (29%) pattern. No significant difference was observed between the codominant, right dominant and left dominant groups regarding age, sex distribution, weight, height, and BMI values (p> 0.05)(Table 2). There was also no significant difference in the codominant, right dominant, left dominant group in terms of HT, DM, and smoking rates (p> 0.05) (Table 2). The P-wave axis, T-wave axis, PR, QRS, and QT values were not significantly different in the codominant, right dominant and left dominant groups (p>0.05) (Table 3). QRS axis value was found to be significantly higher in the left dominant group when compared with the codominant and right dominant group (p<0.05). No significant difference was observed between the codominant and right dominant groups regarding QRS axis values. The axis of (+30)-(+90) ratio in the left dominant group was found to be significantly higher when compared with the codominant and right dominant group (p<0.05). No significant difference was observed between the codominant and right dominant groups regarding the axis of (+30)-(+90) ratio.

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Table 2. Baseline demographics of the study population by coronary dominance

		Co-dominant (n:38)		Right dominant (n:56)		Left dominant (n:39)		p
		Mean.±s.d./n-%Median	Median	Mean.±s.d./n-%Median	Median	Mean.±s.d./n-%Median	Median	
Age		52.1±12.7	55.0	54.0±9.9	55.5	49.4±13.8	52.0	0.358[K]
Sex	Female	20-52.6%		27-48.2%		22-56.4%		0.730[x2]
	Male	18-47.4%		29-51.8%		17-43.6%		
Weight,kg		65.5±12.6	63.3	67.2±11.9	64.8	69.0±12.9	64.0	0.366[K]
Height,m		1.6±0.1	1.6	1.6±0.1	1.6	1.6±0.1	1.6	0.347[K]
BMI		25.5±2.9	25.4	25.6±3.2	25.1	26.1±3.0	25.4	0.675[K]
HT	No	22-57.9%		27-48.2%		19-48.7%		0.613[x2]
	Yes	16-42.1%		29-51.8%		20-51.3%		
DM	No	30-78.9%		41-73.2%		29-74.4%		0.811[x2]
	Yes	8-21.1%		15-26.8%		10-25.6%		
Smoking	No	26-68.4%		42-75.0%		29-74.4%		0.758[x2]
		12-31.6%		14-25.0%		10-25.6%		

BMI; body mass index, DM; diabetes mellitus, HT; hypertension, kg; kilogram, m; meter, s.d; standard deviation, [K]; Kruskal-wallis (Mann-whitney u test), [x2]; Chi-square test

Table 3. Baseline electrocardiographic findings and QRS axis of the study population by coronary dominance

		Co-dominant (n:38)		Right dominant (n:56)		Left dominant (n:39)		p
		Mean.±s.d./n-%Median	Median	Mean.±s.d./n-%Median	Median	Mean.±s.d./n-%Median	Median	
P axis		42.4±20.4	40.0	51.1±26.3	50.0	48.9±19.6	47.0	0.133[K]
QRS axis		22.2±27.2	15.5	24.9±27.4	21.0	38.6±28.6	21.0	0.019[K]
T axis		37.0±20.7	41.0	34.8±26.4	34.0	37.0±29.0	36.0	0.587[K]
PR, msn		148.9±13.0	149.0	148.3±14.7	148.0	148.0±12.+6	148.0	0.943[K]
QT, msn		398.9±25.7	398.0	390.7±23.2	390.0	401.8±25.4	400.0	0.062[K]
QRS axis	(-30)-(30)	26-68.4%		35-62.5%		15-38.5%		0.017[x2]
	(30)-(90)	12-31.6%		21-37.5%		24.61.5%		

[K]; Kruskal-wallis (Mann-whitney u test), s.d; standard deviation, [X²]; Chi-square test

Discussion

In this study, it was determined that coronary artery dominance appears to affect the QRS axis in patients without significant coronary artery disease. The QRS axis significantly moves to 30-90 degrees in left coronary artery dominance patients.

The QRS axis moves leftward throughout childhood and adolescence, and this continues into adulthood. At birth, the normal QRS axis lies between +30 degrees and +190 degrees. Between the ages of 8 and 16 years, the axis moves leftward, normally lying between 0° degrees to +120 degrees. The normal adult QRS axis is between -30 degrees and +90 degrees, which is directed downward and to the left. This adult range is sometimes extended from -30 degrees to +100 degrees [9].

When studies relating to QRS axis are evaluated, in clinical practice a QRS axis shift may be related to coronary artery disease (CAD). Recent reports have pointed out that an exercise- induced QRS axis shift may be related to CAD [10-15]. In a different study, the role of QRS axis change was evaluated in assessing the efficacy of thrombolytic therapy and in determining prognostic infarct size [16]. Also, the change in QRS axis after mitral balloon valvuloplasty was shown to be associated with hemodynamic improvement [17]. We think that if there is a relationship between the QRS axis and coronary artery dominance, may be future risk prediction for coronary atherosclerosis could be done considering some earlier studies [3,18-21]. Our study demonstrated that there was a significant difference in QRS axis between left coronary arterial dominance and other groups.

Previous data have indicated that RCA is dominant in 85% of the patients, while about half of the remaining 15% appear to have left coronary artery dominancy and the other half has a balanced (codominant) circulation [22]. Several studies in the past have reported that age, sex, heart weight, left ventricular wall thickness, and other risk factors were not correlated with coronary dominance [23-25]. Moreover, in these trials, left-dominant circulation is not a predisposition

for coronary atherosclerosis, and the dominant coronary artery pattern does not affect atherosclerosis. In some studies coronary dominance has not been shown to be related with presence and extent of coronary atherosclerosis. In contrast, Vasheghani-Farahani A et al have claimed a significantly higher predisposition to the three-vessel disease in right-dominant patients [21]. Considering these ambiguous findings, patients with CAD were not included in this study.

Although the available data are not clear, previous studies in patients who underwent PCI demonstrated that LD was associated with increased risk of death or re-infarction during long-term follow-up [3, 18, 26]. Similarly, patients with a left dominant or codominant coronary artery system had lower LVEF early after STEMI [27-28]. A left dominant coronary artery tree may have a less well-balanced circulation than other systems, resulting in a larger area of myocardium at risk during acute coronary syndromes. Therefore earlier noninvasive identification of left dominant system may imply better prognosis after a coronary incident with more intensive treatment. In our study, the electrocardiographic QRS axis was found to be related to coronary artery dominancy. In the left-dominant coronary artery group, the QRS axis was found to be between (+30)-(+90) degrees, which was statistically significant. Therefore simple ECG tracing may aid determining coronary dominance.

Our study had several limitations. The first limitation is regarding the number of the patients. To increase the statistical strength of this study, more patients should be included. The second limitation of our study is that the utilization of a software program on the ECG machine to estimate the QRS axis of patients, direct measurement of QRS axis might be more appropriate. The last one only one ECG was evaluated.

Conclusion

Our findings suggested that the QRS axis may be related to coronary artery dominance. We found that the QRS axis is significantly different with left coronary arterial dominancy as compared to right and codominant pattern. However, the reasons for these relationships are not clear. Due to small proportion of left and codominant coronary arterial system in general population our findings should be confirmed with larger and sufficiently powered studies.

Declaration of conflict of interest

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