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Frequency of coronary artery anomalies and relationship between coronary artery with anomalous origin and myocardial bridge

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Abstract

The association between coronary artery with anomalous origin and myocardial bridge is not investigated well yet. We aimed to investigate the incidence of coronary artery anomalies and the relationship between coronary artery with anomalous origin and the presence of myocardial bridge. The coronary angiography records of 6100 patients who undergone coronary angiography in Eskisehir Osmangazi University – school of medicine hospital between 2008 and 2010 were retrospectively assessed. The Angelini classification system was used to classify the coronary artery anomalies. Coronary arteries were classified in three classes: (i) Coronary artery with anomalous origin, (ii) abnormal course (myocardial bridge) and; (iii) termination (fistula). Myocardial bridge is a type of coronary anomaly and is defined as the case where a segment of the epicardial coronary artery is covered by myocardium. The incidence of coronary artery anomalies was 3.1%. Coronary artery with anomalous origin was 1.5%, myocardial bridge was 1.4% and fistula was 0.3%. The frequency of coronary artery anomalies was significantly higher in males (66.7%) than in females (33.3%). Among the coronary arteries with anomalous origin, the circumflex and left descending artery originating from separate ostia in the left aortic sinus was the most common anomaly. Myocardial bridge was significantly higher in males (81.9%) than in females (18.07%). Among the coronary artery with anomalous origin, originating of right coronary artery from left sinus of valsalva was significantly higher with the presence of myocardial bridge ($p<0.05$). In conclusion, it was shown that some types of coronary artery anomalies are seen with myocardial bridge.

Keywords: Congenital anomaly, coronary artery, coronary artery anomaly, anomalous origin, myocardial bridge

Introduction

Coronary artery variations, anatomic patterns and anomalies of coronary arteries are becoming important with an increasing number of coronary angiography procedures. According to their anatomical features, coronary arteries can be divided into three groups: normal coronary anatomy, anatomical variations of coronary arteries and coronary artery anomalies (CAAs). CAAs are congenital anomalies and are usually detected incidentally during coronary angiography. Although most CAAs are benign and do not cause any symptoms or cardiac damage, some of them rarely cause myocardial injury, myocardial infarction or sudden cardiac death by preventing myocardial blood flow [1-3].

The incidence of coronary anomalies has been reported to be 1-1.3% of the population in the previous studies [4-9]. However, with the smooth and more frequent use of coronary angiography, CAAs became more common. In a prospective study performed with 1950 patients using angiography method, the incidence of CAAs were estimated to be 5.6% [10]. Previous studies reported that the incidence of CAAs ranged from 3 to 5%. The myocardial bridge (MB) is a congenital coronary artery variant and is usually seen in the left anterior descending artery (LAD) and is defined as the covering of a particular segment of the coronary artery by the myocardium [11]. It was first described by Reyman in 1737 and included in the literature by Geiringer in 1951 [12,13]. The incidence of MB was found between 0.4% and 15.8% by angiography and between 4.7% and 60% by autopsy series [14]. MB is usually asymptomatic and may occasionally cause ischemia, myocardial infarction, ventricular arrhythmia and sudden cardiac death and it detecte incidentally through coronary angiography or autopsy [15].

This study aimed to investigate the incidence of CAAs, the relationship between CAAs and presence of MB.

Materials and Methods

The data of the "Role of gender in types and frequency of coronary artery aneurysm and ectasia" study [16] was analyzed in terms of incidence of CAAs and the relationship between CAAs and presence of MB. The coronary angiography records of

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6100 patients who undergone coronary angiography in Eskisehir Osmangazi University – school of medicine hospital between 2008 and 2010 were retrospectively assessed. The angiographic videos were carefully reviewed by a qualified and expert interventional cardiologist. Angiographic videos of the patients who had received earlier coronary artery bypass surgery and digital angiography records showing poor quality to review were excluded from the present study. Coronary artery anomalies are classified as coronary artery with anomalous origin (CAAO), abnormal course (myocardial bridge) and termination (fistula). We study the CAAO in detail by determining the anomalous origin of right coronary artery (RCA) arising from circumflex artery (Cx), the presence of split RCA, abnormal origin of Cx – if it is arising from the right aortic sinus or from the RCA, abnormal beginning of LAD from right aortic sinus or from RCA, and originating of the LAD and left main coronary artery (LMCA) from the separate ostia of the left aortic sinus (absence of LMCA). Split RCA was described if the RCA was originating from two separate ostia from the right aortic sinus or arising as a single coronary artery, then dividing into two branches and continuing as duplicate.

Myocardial bridge is described as the case where a segment of the epicardial coronary artery is covered by myocardium. We determined presence of MB if the compression of coronary artery during systole is more than 30% and returning back to its normal state during diastole. In this study, we assessed the incidence and classification of coronary artery anomaly and the association of coronary artery with anomalous origin and presence of MB.

Statistical Analysis

The SPSS statistical software package (SPSS, version 16.0 for Windows; SPSS Inc., Chicago, IL, USA) was used to perform all the statistical calculations. To compare continuous variables, we used Student's t-test or Mann-Whitney U test, where appropriate. Categorical variables were compared via the chi-square test. For all the tests, a value of $p < 0.05$ was considered to be statistically significant.

Results

Coronary artery anomalies was detected in 192 (3.1%) of the 6100 patients. The incidence of CAAs was 3.1% (192 of 6100). The number of coronary artery with anomalous origin was 94 (1.5%), MB was 83 (1.4%) and fistula was 15 (0.3%). Overall, the most common CAA was coronary artery with anomalous origin. The most common type of CAAO was the absence of LMCA (29.1%). The second most common type of CAAO was the presence of the Cx originating from the right sinus of valsalva or RCA (7.8%) and the third most common CAAO was split RCA (5.72%), while the least frequent anomaly was the presence of RCA originating from Cx (0.52%). The details of the frequency and classification of coronary anomalies are summarized in Table 1.

In the present study, we evaluated the incidence of the MB that was detected in 83 (1.4%) patients, whereas, compared by gender, it was significantly higher in males 68 (81.9%) than in females 15 (18.07%). In the present work, we investigated the association between the presence of the CAAO and the presence of MB. When the presence of the MB is compared with all coronary arteries with anomalous origin, association between them was not statistically significant ($p>0.05$). Among the types of the CAAO, the presence of RCA originating from left aortic sinus was significantly higher in patients with presence of MB ($p<0.05$).

Table 1. Frequency of coronary artery anomalies and their clasifications

	Number(n)	Frequency Among the Coronary Artery Anomalies (192)	Frequency among the entire stady population (6100)
Sum of Coronary Aretery Anomalies	192	100%	3.1%
Coronary Artery with Anomalous Origin	94	48.9%	1.5%
Separate Origin of LAD and CX form left Aortic sinus	56	29.1%	0.9%
CX from RCA/RAS	15	7.8%	0.2%
RCA from LAS	7	3.6%	0.1%
RCA from CX	1	0.52%	0%
LAD from RAS	3	1.56%	0.01%
Split RCA	11	5.72%	0.2%
DUAL LAD	9	4.68%	0.1%
Fistula	15	-	0.3%
Myocardial Bridge	83	-	1.4%

Abbreviations: CAA: coronary artery anomaly, CA: coronary artery, LMCA: the left main coronary artery, RCA: the right coronary artery, LAS: the left aortic sinus, Cx: the circumflex artery, RAS: the right aortic sinus, LAD: the left anterior descending artery.

In comparison with the other types of the CAAO with the presence of MB, just the presence of Cx originating from RCA/right aortic sinus was notably higher, but it was not statistically significant (P=0.07). The details of correlation between the presence of the types of coronary artery with anomalous origin and the presence of the MB are summarized in Table 2.

Table 2. Assocation of type of the coronary artery with anomalous origin with mb

	Bridge (+)(n=83)	Bridge (-)(n= 6017)	P Value
Coronary Artery with Anomalous Origin (n,%)	2 (2.4)	92 (1.5)	>0.05
Separate Origin ofLAD and CX form left Aortic sinus (n,%)	0(0)	56 (0.9)	>0.05
CX from RCA/RAS (n,%)	1(1.2)	14 (0.2)	**0.07**
RCA from LAS (n,%)	1(1.2)	6(0.1)	**0.03**
RCA from CX (n,%)	0(0)	6(0.1)	>0.05
LAD from RAS (n,%)	0(0)	9(0.1)	>0.05
Split RCA (n,%)	0(0)	11(0.2)	>0.05
DUAL LAD(n,%)	0	9(0.1)	>0.05

Abbreviations: CAA: coronary artery anomaly, CA: coronary artery, LMCA: the left main coronary artery, RCA: the right coronary artery, LAS: the left aortic sinus, Cx: the circumflex artery, RAS: the right aortic sinus, LAD: the left anterior descending artery.

Discussion

In this study, 192 (3.1%) of 6100 patients were detected to have CAAs. The incidence of CAAs varies from 0.2 to 8.4. In some studies conducted by Hussain B. et al, Angelini et al and Aydar et al, the incidence rate of CAAs were detected to be 4%, 3.34% and 5.6%, respectively [10,17,18]. Although the incidence of CAAs was found higher in our study than some previous studies, it's lower than some recent studies. In a recent study conducted by Cademartiri F et al, with the use of CT angiography, the incidence of CAAs was reported to be 8.4% [19]. Some of the reasons for the higher incidence of CAAs in this study than the previous studies have been assessed below. The most important of these factors is the lack of a precise classification of CAAs. Therewithal, it was thought that the way of collecting data could be one of these reasons. The data in the present study were collected by examining the coronary angiography videos recorded by a specialist interventional cardiologist. However, in most studies it was observed that the data were collected by examining the angiographic reports of the data [2,5,20]. Since the classification of coronary anomalies differs from one study to another, some authors, in their studies, may not have reported a common anomaly as CAA, which may be the reason to observe less frequent CAAs in those studies. In many studies, myocardial bridges and coronary fistulas were not included in the classification of coronary anomalies [2,5,10,20]. In a survey conducted by Angelini et al, CAAs were classified as coronary artery with anomalous origin, abnormal course (MB) and termination anomalies (fistula) [21], but in some studies, the MB and fistula were not considered as coronary anomalies [2,5,9,20]. Another reason for the high frequency of CAAs in this study was thought to be the differences in the classification of CAAO. In the previous studies, the absence of LMCA and split RCA were not included in the classification of coronary artery with anomalous origin [20,22]. CAAs were classified in this study using the Angelini p classification [21]. Considering all these factors, it can be postulated that the differences in the CAAs classification may arise from the evaluation methods of the data and the geographical regions; which both influence the difference in CAAs frequency. In the present study, the most common coronary anomaly was CAAO and the rate was 48.9% of all coronary anomalies and the overall incidence was 1.5% in the entire study population. In the previous studies, the incidence of CAAO was determined to be 0.27-1.66% by coronary angiography and 0.6% by autopsy [2,5,8,23].

The results of the present study were also in agreement with the literature. Absence of LMCA was detected to be the most common anomaly among the coronary artery with anomalous origin and the second most common one was the presence of Cx originating from right aortic sinus and/or RCA. In many studies, the absence of LMCA has been reported as the most common anomaly among the CAAO [5,18,24], however, in some studies, the absence of LMCA and split RCA were excluded from the coronary artery with anomalous origin classification and the most common coronary anomaly was accepted to be presence of Cx originating from right aortic sinus or RCA (0.08-0.41%), and the presence of RCA originating from left aortic sinus (0.018%) was the second most common [5-8,18,24]. Angiographic incidence of the absence of the LMCA was reported to be 0.23% and 0.58% in two studies performed in Turkey [5,18]. In the present study, the LMCA was the most common anomalous vessel and the incidence of absence of the LMCA was 0.9%, higher than those reported in the aforementioned studies. Coronary artery with anomalous origin can rarely cause myocardial ischemia and myocardial infarction by restricting coronary blood flow [1,18,25]. Such anomalies are known as malignant or potentially lethal anomalies. The most common malignant anomaly is the presence of the coronary artery arising from the opposite aortic sinus with a proximal course between aorta and pulmonary trunk. That is to say, the left coronary artery originates from the right aortic sinus or the RCA arises from the left coronary sinus or Cx. In the present study, we detected potentially lethal coronary artery with anomalous origin in 26 patients, while we found 15 occurrences with the presence of Cx originating from the right aortic sinus or RCA (Figure 1), 7 cases with the presence of RCA originating from left aortic sinus, one case with the presence of RCA originating from Cx and 3 cases with the presence of LAD originating from the right aortic sinus. These types of coronary anomalies are particularly vital in young athletes since it is the most common cause of sudden cardiac death after the hypertrophic cardiomyopathy [18]. The MB is a congenital coronary artery variant and is usually observed in LAD. MB is also called as a muscular bridge, intramural coronary artery, mural coronary, tunnel coronary artery or myocardial loop (Figure 2)[25].

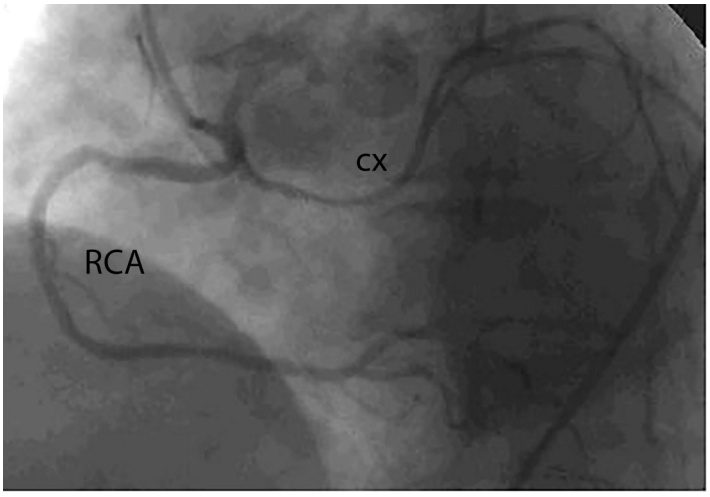

Figure 1. The origin of circumflex artery from right coronary artery

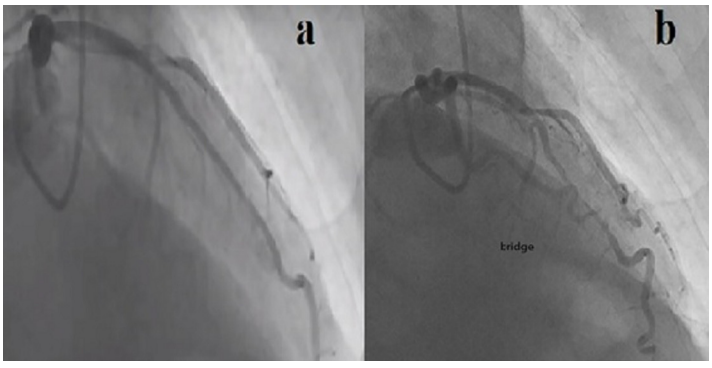

Figure 2. a Left anterior descending artery during diastol **b.** myocardial bridge in left anterior descending artery during sistol

MB is diagnosed by use of angiography, multi-detector CT or autopsy. The incidence was detected in studies as 0.4-15.8% via coronary angiography, as 3.5-58% via, multi-detector CT and 4.7-60% in autopsy [11,18]. In case of considering gender differences, the study performed by Lee and Chen did not reveal any difference between the genders [26], but MB was reported to be observed more in males

than in females in many studies [18,12,27]. In the present study, the incidence of MB was 1.4% and was significantly higher in males than in females, in agreement with the literature. Although CAAO and MB are usually benign, they may rarely lead to malignant arrhythmia, myocardial infarction and sudden cardiac death. Recent studies have shown that MB may be correlated more with coronary artery disease, atherosclerosis and myocardial infarction. Sorin H. et al have demonstrated in their recent meta-analysis and meta-regression that MB may lead to critical cardiovascular results such as myocardial ischemia and major cardiac events [28]. There was no study found on the relation between the coronary artery with anomalous origin and the presence of MB, in the literature. Only a small number of case reports indicate the coexistence of coronary artery with anomalous origin with presence of MB. All of these cases were reported to have MB and CAAO as a result of coronary angiography when they applied with angina pectoris and arrhythmia, and it has been notified that symptoms may arise from the coexistence of MB and CAAO [29,30]. In the present study, the presence of RCA originating from left aortic sinus was significantly higher in patients with presence of MB ($p<0.05$) and the presence of Cx originating from right aortic sinus was higher in patients with presence of MB, but it was not statistically significant (P=0, 07). There was no correlation found between other CAAO and MB. In conclusion, the frequency of coronary anomalies increased with the spread of coronary angiography. Although most coronary abnormalities do not cause serious cardiac problems, some cause many cardiac problems, including cardiac death. During coronary angiography, it should be remembered that several coronary anomalies may coexist. Because coexisting of coronary anomalies very important in terms of both cardiac symptoms and cardiac risk.

Significance of the studyt

Coronary artery anomalies cause myocardial injury, myocardial infarction or sudden cardiac death. The goal of this study was to investigate the incidence of coronary artery anomalies and the relationship between coronary artery with anomalous origin and presence of myocardial bridge.

Conflict of interest

The authors declare that they have no competing interest.

Financial Disclosure

All authors declare no financial support.

Ethical approval

Our study was based on observational and retrospective records of angiography; there for we did not ask for ethic committee!s approval.

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