FREQUENCY OF CORONARY ARTERY ANOMALIES IN ADULT CARDIOLOGY PRACTICE; AN ANGIOGRAPHIC STUDY

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ABSTRACT

Objective: *The aim of this paper was to measure the frequency of various coronary artery anomalies in our patient population who underwent coronary angiography for various indications.*

Methodology: *The data was collected retrospectively by analyzing the angiographic data of 13,615 consecutive patients undergoing coronary angiography between January 2008 and June 2012.*

Results: *Coronary artery anomalies were found in 305 patients (prevalence of 2.2 %). Among these patients, 186 (61.12%) were male and 119(39%) were female. Two hundred and ninety two (95.7%) anomalies were benign and 13(4.2%) were potentially of dangerous nature. Anomalies of the right coronary artery (RCA) in decreasing order of frequency included ectopic RCA from right sinus of valsalva (RSV) 54 (17.7%), coronary ectasia /aneurysm 24(7.8%), fistula 13(4.2%), RCA from left sinus of valsalva (LSV) with anomalous course 11(3.6%) and split RCA 3 (0.98%). Anomalies of the left coronary artery (LAD) in decreasing order of frequency included myocardial bridge 71(23.3%), separate origin of LAD and circumflex from LSV (absent left main trunck) 58(19.02%), circumflex arising from RSV with anomalous course 28(9.18%), coronary ectasia/ aneurysm 23(7.54%), fistula 14(4.5%), LAD arising from RSV with anomalous course 3(0.98%), LCA arising from RSV with anomalous course(retroaortic) 1(0.32%) and single coronary artery 2(0.66%).*

Conclusion: *The prevalence and the pattern of coronary artery anomalies in our patient population were almost identical to previous studies. Cardiologists should be aware of the coronary anomalies because of its potential for serious cardiac events and its importance in interventional cardiology and cardiac surgery practice.*

Key Words: *Coronary artery anomalies, Prevalence, Angiographic study.*

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INTRODUCTION

The definition of the abnormal versus the normal coronary anatomy presents a complex problem that has never been completely solved[1]. Deviations from normal coronary anatomy are termed as variants or coronary artery anomalies (CAA). It has been proposed that a normal variant refers to an alternative coronary pattern that is relatively infrequent compared to normal, but is seen in more than 1% of the population; in contrast to an anomaly that is seen in less than 1% of otherwise normal individuals[2-4]. In an attempt to simplify this matter, some researchers have suggested that coronary anomalies should be classified as major or minor, depending on their pathologic consequences. Recently, most investigators have chosen to use an exclusively anatomic definition that relegates judgments about clinical relevance to a secondary clinical classification[5].

The prevalence of coronary artery anomalies is reported to be approximately 1% to 2% in the general population [5, 6]. The incidence of coronary anomalies is relevant not only for conceptual and educational purposes but, more importantly, for public health issues.[6] Though obtained from small studies, the data imply that 5.6% of the Americans have some kind of coronary anomaly[1,7]. Congenital coronary artery anomalies (CCAA) are frequently found (in about 20% of cases), and they represent the second most frequent disease responsible for athletic field deaths [8]. Specifically, the wrong sinus coronary artery origin, that is, the left main artery arising

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from the right anterior sinus (ALMCA) and the right coronary artery originating from the left sinus (ARCA), with a proximal course between aorta and pulmonary trunk, are the most frequent occurrences of CCAA[9-14].

The clinical presentation is variable and the abnormality may remain clinically occult or it can have life-threatening consequences, such as myocardial infarction, arrhythmia, or even sudden death[15]. Even if the anomalies are asymptomatic, knowledge of their presence is important at cardiac surgery to avoid inadvertent damage to a vessel with an anomalous course[15].

Various imaging modalities are available for coronary artery assessment. Traditionally, catheter angiography has been used to evaluate the coronary arteries and their anomalies; however, it is an invasive technique, and the exact course of the coronaries can sometimes be difficult to determine precisely. Increasing cardiac computed tomography (CCT) and magnetic resonance imaging (MRI) are being used in the evaluation of coronary arteries anomalies. They are noninvasive and have multiplanar capability[15-17].

There are very few studies which address the prevalence of coronary artery anomalies in our population. In this study, our aim was to find the prevalence of various coronary artery anomalies in patients who underwent coronary angiography for various indications.

METHODOLOGY

This retrospective study was carried out at the department of cardiology, Postgraduate Medical institute, Lady Reading Hospital Peshawar from January 2008 to April 2012 for a total period of 4 years. We reviewed the database of 13,615 adult patients who underwent coronary angiography for any indications to look for coronary artery anomalies. Patients of both genders and age above 18 years were included in the study. Coronary angiographies had been performed for stable coronary artery disease, acute coronary syndrome, valvular heart disease, peripheral arterial disease and adult congenital heart disease. However, angiograms of pediatric age group and separate origin of the conus branch from RSV were excluded. As this was a retrospective study, we were unable to take consent from patients. Demographic characteristics of patients including age and gender were obtained from patient's record.

At least two independent investigators reviewed the angiographic films, which were selected for further assessment, prior to the final classification. Diagnosis from both cardiologists was looked for similarity and in case of agreement between the two, final diagnosis was made. In the event of any discrepancy between the two reviewers, a consensus was reached after discussion and opinion of third interventional cardiologist. Most of the selected coronary angiographies were performed through Judkins (femoral artery access) method, although some were done through Radial artery access.

The course of anomalous artery was defined according to the guidelines of Yamanaka and Hobbs and the "eye-and-dot method"[11,12]. Coronary anomalies were classified as following. **Left coronary artery (LCA)**: Absent left main trunk (split origin of LCA, when no left main stem was visible on all standard angiographic views and left circumflex artery and left anterior descending artery have separate origin from left sinus of valsalva). **LCA or LAD or Circumflex arising from right sinus of valsalva, with anomalous course**: retroaortic, interarterial and prepulmonic. The origin of left coronary artery was confirmed in left anterior oblique view (LAO) and its course determined with help of right anterior oblique view. Coronary ectasia/aneurysm was determined if there was dilation of coronary artery beyond the normal reference vessel diameter. Myocardial bridge was diagnosed if a segment of coronary artery has narrowing of more than 50% in systole but normal during diastole. Anomalous left coronary artery from pulmonary artery (ALCAPA) was diagnosed when left anterior descending artery originate from pulmonary artery and draining blood from RCA through collaterals in pulmonary artery. Single coronary artery was diagnosed when there was one coronary artery supplying the whole heart.

Right coronary artery (RCA): Ectopic RCA from right sinus of valsalva was diagnosed when the RCA had high anterior or posterior origin from RSV. Fistula of RCA was diagnosed when RCA drain in one of heart chamber i.e. right atrium or right ventricle. Coronary ectasia/ aneurysm was determined if there was dilation of coronary artery beyond the normal reference vessel diameter. Anomalous right coronary artery from pulmonary artery (ARCAPA) was diagnosed when RCA originated from pulmonary artery. Split RCA was diagnosed as an RCA that featured a split posterior descending branch, with the anterior subdivision of the RCA leading to the distal portion of the posterior descending branch (which serves the posterior septum and the inferior wall of the left ventricle), but also leading to the anterior free wall of the right ventricle. The other (posterior) bifurcation of the RCA maintains a course in the atrioventricular groove and forms the uppermost portion of the posterior descending branch. RCA arising from left sinus of valsalva,

with anomalous course: retroaortic, interarterial, prepulmonic. The origin of coronary artery was confirmed in left anterior oblique view (LAO) and its course determined with help of right anterior oblique view.

Data was analyzed using statistical package for social sciences (SPSS) version 16. Data is presented as mean (±SD) for numerical variables and number and percentage for categorical variables in the forms of tables. From frequency of each anomaly, prevalence was determined.

RESULTS

A total of 13,615 coronary angiograms were screened in which 11382(83.6%) were done for stable coronary artery disease, 1048(7.7%) for acute coronary syndrome, 435(3.2%) for valvular heart disease, 272(2%) for peripheral arterial disease and 476(3.55) for adult congenital heart diseases. These are summarized in Table 1. Coronary artery anomalies were found in 305 patients (prevalence of 2.2 %). Among these patients, 186 (61.12%) were male and 119(39%) were female. Two hundred and ninety two (95.7%) anomalies were benign and 13(4.2%) were potentially of dangerous nature. These are summarized in Table 2.

Anomalies of the right coronary artery in decreasing order of frequency included ectopic RCA from RSV 54 (17.7%), coronary ectasia /aneurysm 24(7.8%), fistula 13(4.2%), RCA from LSV with anomalous course 11(3.6%) and split RCA 3(0.98%). Ectopic RCA from RSV was the most of RCA anomalies. These are summarized in Table 3.

Myocardial bridging was the most common of LCA anomalies. Anomalies of the left coronary artery in decreasing order of frequency included myocardial bridge 71(23.3%), separate

Table 1: Main indications for coronary angiography in screened population (n=13615)

Indication for coronary angiography	Frequency	Percentage (%)
Stable angina	11382	83.6
Acute coronary syndrome	1048	7.7
Valvular heart disease	435	3.2
Peripheral artery disease	272	2
Adult congenital heart disease	476	3.5

Table 2: Baseline characteristics of patients having anomalous coronary arteries and main groups of coronary anomalies

Characteristics	Frequency	Percentage(%)	Prevalence	Mean±SD
Age(years)±SD				53.60±11.02
Male	186	61.12		
Female	119	39		
Total coronary anomalies	305		2.2	
Coronary anomalies excluding ectasia/ aneurysm	258		1.8	
Anomalies of origin and distribution	160	52.45	1.2	
Coronary artery communications and fistulae	27	8.85	0.19	
Anomalies of intrinsic coronary arterial anatomy	118	38.68	0.87	
Benign anomalies	292	95.7	2.14	
Potentially serious	13	4.2	0.09	

Table 3: Anomalies of right coronary artery.(LSV=left sinus of valsalva)

Anomaly	Frequency	Percentage (%)	Prevalence
Ectopic RCA from RSV	54	17.7	0.4
Fistula	13	4.26	0.09
Coronary ectasia/ aneurysm	24	7.8	0.18
RCA arising from LSV, with anomalous course	11	3.60	0.08
Retroaortic	6	1.96	0.04
Interarterial	1	0.32	0.007
Prepulmonic	4	1.31	0.03
Split RCA	3	0.98	0.02

Table 4: Anomalies of left coronary artery

Anomaly	Frequency	Percentage (%)	Prevalence
Absent left main trunk (separate origin of LAD and CIRC)	58	19.02	0.42
LCA arising from RSV with anomalous course(retroaortic)	1	0.32	0.007
LAD arising from RSV with anomalous course	3	0.98	0.02
Retroaortic	2	0.66	0.01
Interarterial	0		
Prepulmonic	1	0.32	0.007
Circumflex arising from RSV with anomalous course	28	9.18	0.20
Retroaortic	18	5.90	0.13
Interarterial	3	0.98	0.02
Prepulmonic	7	2.29	0.05
Myocardial bridge	71	23.27	0.52
Fistula	14	4.59	0.10
Coronary ectasia/ aneurysm	23	7.54	0.17
Single coronary artery	2	0.66	0.01

RSV=Right sinus of valsalva, LCA=Left coronary artery, LAD=Left anterior descending, CIRC=Circumflex

origin of LAD and circumflex from LSV (absent left main trunk) 58(19.02%), circumflex arising from RSV with anomalous course 28(9.18%), coronary ectasia/ aneurysm 23(7.54%), fistula 14(4.5%), LAD arising from RSV with anomalous course 3(0.98%), LCA arising from RSV with anomalous course(retroaortic) 1(0.32%) and single coronary artery 2(0.66%). These are summarized in Table 4.

DISCUSSION

The prevalence of coronary artery anomalies shows a wide variation. They are usually encountered as coincidental findings during coronary angiography or at autopsy. In different studies, the prevalence was reported as 0.6% to 1.3%[18]. For some anomalies like myocardial bridge, the frequency reported in angiographic studies varies from 0.5 to 16%[19]. Similarly, we found 1.8 % prevalence of coronary artery anomalies among patients undergoing diagnostic coronary angiography.

Coronary artery anomalies are classified as anomalies of origin and distribution, coronary artery fistula and communication and anomalies of intrinsic coronary arterial anatomy. The anomalies

of origin and distribution of the coronary arteries was stated to be 89.3% and coronary artery fistulae to be 10.7% in various studies[18,20,21] . In our study these were 91 % and 9% respectively. The most common anomaly in our study group was myocardial bridge of left anterior descending artery 71(23.2%). It is the most common coronary anomaly, with an incidence between 1.5% and 16% as assessed by coronary angiography. Although it is considered a harmless malformation in most patients, clinically relevant complications may be associated with it which includes myocardial ischemia, conduction disturbances, myocardial infarction and sudden death[22,23].

The second most common coronary anomaly in our study was separate ostia of LAD and LCX in the absence of LMCA (19.02%) which is similar to previous publications[18,21]. RCA and LCX anomalies were the third most common anomaly. The prevalence of RCA either from ectopic position from right sinus of valsalva or from left sinus of valsalva was stated to 1.13 % and 0.92% respectively[6]. In our study these were 0.4% and 0.08% respectively. In our study, RCA from left sinus of valsalva were either retroaortic or prepulmonic in course showing their benign nature. This was followed by LCX originating from the right sinus of Valsalva in 28(9.18%) patients. This anomaly was further characterized by retroaortic course in 18(0.13%) of patients, interarterial in 3(0.02%) and prepulmonic in 7(0.05%). This anomaly was seen in 11% and 18.4% of all coronary anomalies in similar studies[18, 21]. The incidence of the LCX arising from the RCA is generally believed to be of no clinical significance due to a dorsal course the left ventricle[24].

The anomalous origin of the LMCA from the right coronary sinus of Valsalva is a rare congenital coronary anomaly which was found in 0.017% of patients[18,25,26]. We found 1 (0.007 %) patient with this anomaly among 13,615 patients. The LMCA, LAD, and RCA may arise from the pulmonary artery in the order of decreasing incidence. Unfortunately, about 90% of patients with these anomalies die during infancy[21]. We had no patients with these anomalies because only adult patients were included in our study.

The LMCA or LAD arising from the right sinus of valsalva and RCA originating from the left coronary sinus of Valsalva deserve clinical attention because these anomalies may be associated with sudden cardiac death in otherwise fit individuals[12,13,24,25]. There were 15 patients with these kind of anomalies in our study population (LMCA from right sinus of valsalva (RSV) in 1 patient, LAD from right sinus of valsalva (RSV) in 3 patients and RCA from the left coronary sinus of Valsalva in 11 patients). It is important to differentiate this interarterial course from intraseptal (which may appear similar, but the anomalous vessel passes more inferiorly within the muscular septum) and the posterior course that have relatively benign courses than the first one. Because of the unusual location and the noncircular coronary orifice of these anomalies, selective catheterization and percutaneous intervention can be technically challenging, particularly with regard to adequate guide catheter support[12].

Coronary artery fistulas (CAF) are rare congenital anomalies[27]. The incidence is around 0.002% in the general population and 0.3% to 0.4% in patients with congenital heart defects[28,29]. The CAF incidence in our study was 0.10% among patients undergoing diagnostic coronary angiography. Coronary artery fistulas consist of a communication between a coronary artery and a cardiac chamber or a great vessel. In CAF, blood diverting from the high resistance myocardial capillary bed into the low resistance fistula produce ischemia and coronary steal phenomenon[30].

LIMITATIONS

The limitation of our study is that only the patients who had undergone coronary angiography were included rather than a randomly selected sample of the whole population. Secondly pediatric age group was not included. So it may not reflect the true prevalence of coronary artery anomalies in our general population.

CONCLUSION

Coronary artery anomalies are not uncommon in our patient population and its prevalence is similar to what is reported in other populations. Angiographic recognition of these anomalies has an important clinical impact in coronary angiography, angioplasty or cardiac surgery, particularly in avoiding unnecessary procedures or surgical accidents.

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CONTRIBUTORS

IS conceived, conducted, analyzed and wrote the manuscript of the research. MF, S & R helped in data collection & write up of the study. All the authors contributed significantly to the research that resulted in the submitted manuscript.