DOI: https://doi.org/10.53350/pjmhs20221612245

ORIGINAL ARTICLE

Prevalence and Pattern of Congenital Coronary Artery Anomalies in Patients Undergoing Coronary Angiography at a Tertiary Care Hospital

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ABSTRACT

Objective: This research aimed to characterize the clinical presentation, frequency, and distribution of CAAs in people experiencing angiography. In this study, we reviewed the presence of CAAs in 4072 patients.

Study design: Cross-section study

Study Setting: Current research was conducted at Department of interventional cardiology, MTI- Hayat Abad Medical Complex, Peshawar from Ist July 2021 to 30th June 2022.

Methods: The current research analyzed data from 4072 angiograms performed. The medical record of the patients was used to recruit the CAAs patient's profile. Angelini's categorization was used to categorise the coronary anomalies and two interventional cardiologists reviewed each coronary angiography separately, and in the event of a discrepancy, a senior cardiologist was contacted to achieve a consensus. GE 520 and GE 2100 were used for the coronary angiogram. Operators have the option of using either a radial or femoral incision.

Results: Finding of the CAAs was found in 103 cases of CAAs (a prevalence of 2.5%). According to the data, the average age of the patients was 59.64±13.73. Of them, 89 (2.19%) individuals had anomalous coronary origin and/or course, 9 (0.2%) had intrinsic coronary arterial system abnormalities, 3 (0.07%) had anomalous coronary termination, and 2 (0.04%) had a single coronary artery. Overall, 36 individuals (0.44%) were found to have an aberrant right coronary artery (RCA), with the RCA emerging from the left coronary sinus; this was followed by 54 patients (1.3%) who lacked a left main trunk and instead had a distinct origin for the LAD and LCX.

Practical implication: Our understanding of CAAs has considerably improved from the development of novel diagnostic techniques, although the majority of the data available today comes from case reports and small case series. Further research is needed to fill the knowledge gap regarding the clinical effects of CAAs and their prognosis because epidemiological data are taken from studies conducted in other countries.

Conclusion: Overall, 2.5 percent of research participants had congenital coronary abnormalities. The highest prevalence was found in anomalies origin and course. This study's prevalence of CAAs was comparable to that of other research, although the distribution of abnormalities was a little bit different.

Keywords: Congenital Coronary Artery Anomalies, Coronary Angiography, Prevalence, Pattern

INTRODUCTION

Coronary artery anomalies (CAAs) are a collection of congenital illnesses characterized by abnormalities in the coronary arteries, including their beginnings, paths, endings, and other intrinsic features. Approximately 1% of the general population experiences CAAs.[1] However, this number varies widely among studies. Numerous investigations, including coronary angiography patients, have revealed incidences ranging from 0.3% to 5.6% of this phenomeno.[2] A variety of categories, some of which are based on the functional significance of specific abnormalities or anatomical traits. CAAs are divided into three groups according to their clinical significance: abnormalities with mandatory ischemia, irregularities in the absence of ischemia.[3] Though CAAs are uncommon, knowing their exact course and distribution is crucial before undergoing revascularization treatments. CAAs make selective cannulation more challenging, and inadvertent injury to the arteries must be avoided. The geographical distribution of CAAs varies in pattern and prevalence.[4] Patients with or without atherosclerotic coronary artery disease may benefit from angiographic detection of anomalous coronary arteries. Although many congenital disabilities of the coronary arteries are present at birth, only a tiny percentage cause symptoms in childhood.[5] Coronary angiography and autopsy are the two most common methods for discovering abnormalities. However, specific abnormalities may manifest with symptoms such as angina pectoris, myocardial infarction, syncope, cardiac arrhythmias, sudden death, and congestive heart failure. Although angiography is necessary to accurately determine the distribution of coronary anomalies, non-invasive procedures are now available to aid in diagnosing coronary artery anomalies.[6]

Using angiography, this research characterizes the prevalence and distribution of coronary artery abnormalities in a Pakistani population of Khyber Pakhtunkhwa. In addition, we established a straightforward morphological categorization of congenital cardiac abnormalities that may be used in routine clinical settings.[7] Clinical manifestations may range from inconspicuous to life-threatening. Prevalence estimates for the general adult population range from around 1% to 2%, depending on the series used for analysis (angiographic or autopsy). The frequency varies from 0.6% in angiographic studies to 5.64 % in autopsy data, however most people with CAAs do not have any symptoms.[8] Although there has yet to be a consensus on the proper categorization or naming of CAAs, a pattern is considered normal if it is seen in at least 1% of the population and abnormal if it is observed in less than one percent of the population. Additionally, the CAAs are classified into 4 subtypes: anomalies of origin and course, intrinsic abnormalities of coronaries, anomalies of termination, and abnormal anastomotic vessels. These arteries may accidentally be damaged during heart surgery.[9]

It is widely known that the prevalence of various cardiac anomalies varies geographically. There is a dearth of Pakistani data in this area. The importance of CAAs is that they may present diagnostic and therapeutic problems, such as making it difficult to engage coronary ostia or necessitating the use of special catheters and manoeuvres during angiography or angioplasty, lengthening the fluoroscopic duration. When doing heart surgery, accidental injury to these vessels may occur due to a lack of awareness of anomaly. We discuss our experiences with primary coronary anomalies found during a regular coronary arteriography in this paper.

MATERIAL AND METHODS

Study Setting: Study was conducted at Department of interventional cardiology, MTI- Hayat Abad Medical Complex, Peshawar.

Study Design: Cross-section study
Study Duration: Six months from 1st July 2021 to 30th June 2022.
Sample Size: The current research analyzed data from 4072 angiograms performed.
Sample Technique: A consecutive sampling technique was used.
Methodology: In accordance with the guidelines set out by our hospital's institutional ethics committee (IEC) this observational research was conducted. Patients who had undergone CAG and were over the age of 18 and suffered from ischemic heart disease and valvular heart disease were considered for participation in the study. Patients with complex congenital cardiac disorders, varying degrees of coronary artery "take-off," and a distinct origin for the CONUS artery from right coronary sinus (RCS) were excluded. Also, exclusion criteria was if coronary abnormalities such as myocardial bridging, ectasia, or a conus artery that did not originate from the right coronary sinus. Patients with a CAG indication were given information about the surgery after a medical history was taken, a physical examination was conducted, and laboratory tests were run. Patients were moved to the catheterization lab for diagnosis and treatment after giving informed consent and being cleared for the procedure.

Angelini's categorization was used to categorise the coronary anomalies and two interventional cardiologists reviewed each coronary angiography separately, and in the event of a discrepancy, a senior cardiologist was contacted to achieve a consensus. GE 520 and GE 2100 were used for the coronary angiogram. Operators have the option of using either a radial or femoral incision.
Data Analysis: Descriptive statistics were employed to examine CAA prevalence; percentages/frequencies and mean and standard deviation (SD) was used to report categorical and continuous variables, respectively.

RESULTS

Over the course of 1 year and 4072 angiograms, we identified 103 instances (2.5%) of various CAAs. There were 1245 (30.6%) male and 2827 (69.4%) were female and 56 (63.64%) were reviewed. The average age of patient was 59.64±13.73 years old. Chronic stable angina (CSA) (N=36, 34.95%), valvular heart disease (N=04, 3.88%), and dilated cardiomyopathy (N=01, 0.97%) followed by Acute coronary syndrome (N=62, 60.19%) as the most prevalent reasons for angiography among these patients (Table 1).

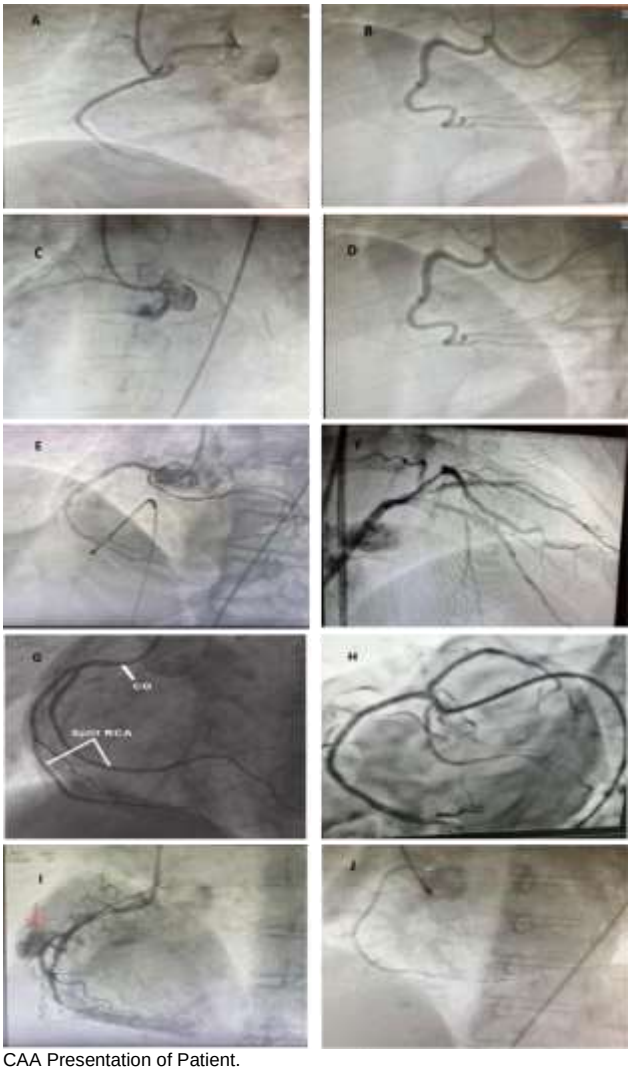
The Left Anterior Descending Artery (LAD) and the Left Circumflex Artery (LCX) Do Not Share a Common Origin Due to the Lack of a Left Main Trunk. The most prevalent abnormality of about Fifty-four individuals (angiographic frequency of 1.3% and anomaly incidence of 52.43%) were found to have the LAD and LCX originate independently from the left coronary sinus in the non-existence of the left main trunk. Our research showed that this was the second most prevalent kind of irregularity other abnormality shown in table 2. The patient's abnormality images are shown from figure A-J.

Table 1: Baseline characteristics and pattern of coronary anomalies. All values are presented as mean ± SD or number (%). CAA: coronary artery anomalies

Characteristics	N (%)
Total Number of Reviewed Coronary Angiograms	4072
Indivuduals with CAAs	103 (2.5)
Anomalies of coronary origin and course	89 (2.19)
Anomalies of coronary arterial anatomy	9 (0.2)
Anomalies of coronary termination	3 (0.07)
Single coronary artery	2 (0.04)
Mean (range) age in years of CAA patients	59.64±13.73
Gender Distribution of Patients with Caas	
Number of males	1245 (30.6)
Number of females	2827 (69.4)
Indication for Coronary Angiography	
Acute coronary syndrome	62 (60.19)
Chronic stable angina (CSA)	36 (34.95)
Valvular heart disease	4 (3.88)
Dilated cardiomyopathy	1 (0.97)

Table 2: Prevalence of various coronary artery anomalies. LAD: left anterior descending, LCS: left coronary sinus, LCX: left coronary circumflex, LCA: left coronary artery, RCA: right coronary artery, RCS: right coronary sinus.

Coronary Anomaly	No. of Patients (n=4072)	Angiographic Incidence (%)	Anomaly Incidence (%)
Anomalous Origin and Course			
Absent Left Main Trunk			
> Separate origin of LAD & LCX	54	1.3	52.43
Anomalous Location of Coronary Ostium Outside Normal Aortic Sinus			
RCA arising from left coronary sinus	18	0.44	17.48
Posterior origin of RCA within right coronary sinus	7	0.2	6.80
High origin of RCA	3	0.07	2.91
LCX arising from right coronary sinus	6	0.14	5.83
LMCA arising from right coronary sinus	2	0.04	1.94
Anomalies of Intrinsic Coronary Artery Anatomy			
Split RCA	4	0.11	3.88
Split LAD	6	0.14	5.83
Anomalies of Coronary Termination			
RCA to right atrium fistula	1	0.02	0.97
Single Coronary Artery			
	2	0.04	1.94
Total	103	2.5	



CAA Presentation of Patient.
Figure A: Coronary angiogram showing posterior origin of RCA in right coronary sinus
Figure B: Coronary angiogram showing anomalous RCA and LCX arising from Right coronary sinus

Figure C: Coronary angiogram showing anomalous origin of RCA from Left Coronary Sinus
Figure D: Coronary angiogram showing LCX arising from Right Sinus
Figure E: Coronary angiogram showing anomalous origin of Left Main Coronary Artery from Right coronary sinus
Figure F: Coronary angiogram showing Split Left Anterior Descending Artery
Figure G: Coronary angiogram showing Split Right coronary artery
Figure H - Single coronary artery from left sinus
Figure I: Coronary angiogram showing right coronary artery to right atrium fistula
Figure J: High origin of RCA

DISCUSSION

Congenital anomalies (CAAs) include a broad spectrum of illnesses with unusual causes, aberrant progression, abnormal endpoints, and inherent abnormalities. Functional significance and anatomical characteristics have been the primary pillars upon which CAAs have been grouped. This current investigation found a prevalence of CAAs of 2.5%, consistent with the 0.3%-5.64% incidence in earlier studies.[10]

Right coronary artery (RCA) anomalies originating from the left coronary sinus were the predominant RCA abnormality in this investigation. 0.44% angiographic prevalence was found after being seen in 18 cases. Similarly, high prevalence rates have been reported by (0.22%).[11] However, some studies have shown lower occurrence rates, with a prevalence of 0.10% and 0.1%.[12,13] With inter-arterial RCA patients showed the increased risk for myocardial ischemia, which can lead to life-threatening clinical manifestations.[14]

The left main trunk is absent with the independent origin of the left anterior descending (LAD) artery and the left circumflex artery was the second most frequent aberration found in the research (LCX).[14] Twenty individuals had this, making the anomaly incidence 22.72 percent and the angiographic prevalence 0.56 percent. Percentages ranging from 0.74 percent, 0.37 percent, 0.69 percent, 0.16 percent, 0.45 percent, 0.43 percent, and 0.60 percent have been reported elsewhere. The clinical manifestations of this CAA variant are negligible.[11,13]

Thirteen patients (0.36 %) had RCAs that originated in the posterior wall of the right coronary sinus. It has a relatively low incidence rate of 0.16 percent and may be harmless. Our research showed that posterior origin of RCA within right coronary sinus caused by RCS was the 0.2 % most prevalent abnormality among 7 patients.

Both (0.28%) and (0.25%) have reported seeing this peculiarity at almost the same frequency. However, these estimates are lower than the values published by (0.34%) and (0.33%). Compared to what was reported by (0.17%), is higher. Although this abnormality is often harmless, it may cause complications after valve surgery.[15]

Out of every 3,000 angiographic examinations, one patient had an abnormality in the left significant coronary artery originating from the right coronary sinus. There is little chance that you may experience this anomaly in your lifetime; estimates range from 0.03 to 0.15% (16). However, this abnormality has significant clinical importance due to its connection with abrupt cardiac mortality, particularly during strenuous activity.[16]

We found that split RCA is the sixth most prevalent aberration when the posterior descending artery (PDA) branches off of the RCA at an earlier origin than usual. The most common coronary abnormality (0.11%) was seen in 4 individuals, with an angiographic frequency of 3.88%. Six individuals (0.14%) had a split LAD, defined as a LAD with a large septal or major diagonal branch that also gave minor septal branches.

Our analysis revealed a prevalence of 0.02% for abnormal coronary terminations (right coronary artery to right atrium fistula) which is similar to the prevalence reported by (0.02%). Significant anomalies, including RCA anomalous origin from the left coronary sinus, have been recorded at a prevalence of 0.1%.[15]

There are two potential abnormal origins for the LCX: (1) a distinct LCX emerging from the left coronary sinus and (2) an RCA or correct coronary sinus anomaly arising close to the RCA ostium. When the latter occurs, the path is often retro aortic and clinically benign.[17]

The occurrence of an abnormal LMCA origin from the right coronary sinus is low. There are four potential outcomes. An intra-arterial route between the aortic root and the pulmonary artery. The usual path of the LMCA involves it ascending and then angling posteriorly to the right ventricular outflow tract before moving forward to its bifurcation. Instead, it follows a septal trajectory. The LMCA's path along the right ventricular outflow tract floor might be either intramyocardial or subendocardial.[18] Afterwards, it emerges in the mid-septum and divides into the LAD (only the mid and distal segments are present) and LCX (the initial portion courses toward the aorta). Septal perforator branches originating from the LMCA are another possible indicator.[19,20]

Course (with) in front of the right ventricular outflow tract. The anterior cranial loop formed by the LMCA's course first to the right, finally reaching the inter-ventricular groove and separating correctly, allowing the artery to pass anteriorly over the right ventricular outflow tract. Course posterior to the aortic root, or retro aortic. To the right of the RCA, the LMCA might originate and travel behind the aortic root.[21]

This abnormality is clinically relevant because it increases the risk of sudden cardiac death, particularly during intense physical activity. The right coronary sinus is the origin of the LMCA, and its abnormal path may be fatal.[22]

Ischemia caused by LMCA abnormalities has been linked to various potential causes. The ordinary coronary artery branches right to the aorta, but the anomalous coronary artery branches off at an acute angle and doubles back on itself before supplying the heart properly. This causes the ostium of the anomalous coronary artery to be narrower and more slit-like than it would be in a normal coronary artery. As angulation increases, so does the chance of ischemic damage.[17]

These problems often manifest themselves after or just after a strenuous workout. Exercising causes the aortic root and pulmonary trunk to enlarge, so extending the aorta wall, which in turn causes compression leading to more ischemia.[23] With intravascular ultrasonography, it was shown that the coronary artery is compressed between the aorta and the pulmonary artery and that the intra-mural section of the artery is compressed laterally.[24] Myocardial ischemia may be caused by many different processes. However, other writers have speculated that aberrant pathways might produce endothelial damage and dysfunction, which could cause coronary artery spasms.[24]

The vast majority of CAAs are symptom-free and are only discovered accidentally during routine angiography. Some abnormalities manifest in the young person's life as abrupt cardiac death. Among athletes, CAA has been linked to 19% of fatalities.[25] Symptoms include episodes of chest discomfort, fainting, difficulty breathing, dizziness, fainting, heart failure, ventricular arrhythmias, heart attacks, and even sudden cardiac death. In most cases, symptoms manifest after strenuous physical activity, and doctors diagnose it as an abnormal origin of the LMCA or RCA from the opposite coronary sinus.[26]

Limitation: The prevalence of CAAs in the population may be higher or lower than what was found in this single-center investigation. The research also excluded the general population since it only included those who had coronary angiography for severe chest discomfort, acute coronary syndrome, chronic stable angina, valvular heart diseas4e and dilated cardiomyopathy.

CONCLUSION

In the current investigation, CAA prevalence was found to be 2.5 percent. In particular, origin and trajectory abnormalities tended to be overrepresented. While comparative investigations have been conducted in other regions of the globe, the anomaly patterns documented here were unique to this investigation. In general, the lack of the left main trunk with the distinct origin of the left anterior descending (LAD) and left circumflex (LCX) arteries is the most

prevalent abnormality, followed by the abnormal placement of the coronary ostium outside the normal aortic sinus of Valsalva. Although CAAs are uncommon, correct diagnosis is crucial for cardiac patients to be treated appropriately. CAAs were generally harmless but recognizing them on an angiogram is crucial for moving forward with coronary angioplasty or surgery.

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