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Original Article

Internal Medicine Section

Prevalence of Coronary Artery Anomalies and Associated Complications during Catheter-guided Angiography: A Retrospective Study

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ABSTRACT

Introduction: Coronary Artery Anomalies (CAA) refer to very uncommon and unusual morphological features of the epicardial coronary artery that account for 1/5th of deaths in athletes. Patients with CAA are also prone to developing significant Coronary Artery Disease (CAD). Identifying such arteries during catheter-guided angiography is very challenging and is associated with many devastating complications, such as arrhythmia, heart failure, Contrast-Induced Nephropathy (CIN), bleeding, cardio-embolic events, and mechanical injury to the coronary artery, among others.

Aim: The aim of this study is to describe the prevalence of various types of coronary anomalies and the complications that arise during catheter-guided angiography.

Materials and Methods: A retrospective study was conducted between February 2022 and October 2022, enrolling a total of 2849 patients who underwent angiography for angina or angina equivalents at the catheterisation laboratory, VIMSAR, Burla, Odisha, India. Angiographic records and videos of patients were noted. Coronary anomalies were detected based on quantitative and qualitative criteria provided by the American Heart Association in 2007. The anomalous coronary arteries were classified into three groups: Group A- anomalies of origin and course, Group B- anomalies of intrinsic coronary arterial anatomy, and Group C- anomalies of coronary termination. Data regarding baseline characteristics and procedure-related complications were collected, compiled, and tabulated to determine the prevalence of different types of coronary anomalies and the arising complications during catheter-guided angiography.

Results: Among the 2849 enrolled patients, CAA was identified in 64 (2.24%) patients. Of these, CAA with abnormal origin and course (Group A), abnormal termination (Group B), and intrinsic coronary arterial anatomy (Group C) were detected in 36 (1.26%), 4 (0.14%), and 24 (0.84%) patients, respectively. Out of the 64 cases, a total of 13 (20.3%) patients developed different types of complications, including mechanical 2 (3.125%), embolic 1 (1.56%), and arrhythmic 3 (4.68%) complications, bleeding 2 (3.12%), angiographic 3 (4.68%), and left ventricular failure 2 (3.12%), among others. In Group A, complications were more commonly observed in 10 (15.6%) of the cases.

Conclusion: CAA with an abnormal origin and course is the most common type of coronary anomaly. Engaging such an artery and detecting its abnormal course are more commonly associated with life-threatening complications. The use of appropriate maneuvers, types and sizes of catheters, and CIN views can help avoid disastrous complications.

Keywords: Arrhythmia, Cardioembolic events, Epicardial coronary artery

INTRODUCTION

The CAA refers to a very uncommon (<1% in the unselected general population) and unusual morphological features (intrinsic anatomy, origin, course, or termination) of the epicardial coronary artery [1,2]. Patients with CAA are prone to develop CAD and sudden cardiac death due to their unusual morphological features [3]. Catheter-directed angiography is the gold standard procedure for the diagnosis of CAD [4]. Devastating complications (arrhythmic, mechanical, iatrogenic, cardio-embolic, bleeding, etc.) arise more frequently due to delayed identification and difficult engagement during angiographic procedures [4,5].

Although studies regarding the prevalence of coronary anomalies are prevalent, studies regarding the prevalence with respect to their morphologic subtypes are very limited [6-11]. More surprisingly, to date, no study has been conducted regarding the prevalence of complications arising during angiography in cases of coronary anomalies with regard to their morphological subtypes, creating a significant knowledge gap in this regard. Therefore, the present study was planned to determine the prevalence of different types of CAA and their procedure-related complications to derive a solution to reduce the risk to patients.

MATERIALS AND METHODS

A retrospective study was conducted in the catheterisation laboratory, Department of Cardiology, VIMSAR, Burla, Odisha, India, between February 2022 and October 2022, after obtaining the approval of the Institutional Ethics Committee (IEC number-153/I-F-O/21).

Inclusion and Exclusion criteria: Patients who underwent coronary angiography (for angina or angina equivalents) over a period of the last 11 years, between 2011 and 2022, were included in the study, whereas patients with inconclusive angiography reports were excluded from the study.

Study Procedure

A total of 2849 patients were enrolled in the study. Registered angiographic records of the patients were analysed and recorded using a predesigned template. Angiographic videos of patients with coronary anomalies, stored in the catheterisation lab, either on Personalised Computer (PC) or Compact Disc (CD) format, were thoroughly reviewed by two cardiologists. Coronary anomalies were Detected during review and classified as follows:

- Group A- Anomalies of origination and course,
- Group B- Anomalies of coronary termination,
- Group C- Anomalies of intrinsic coronary arterial anatomy [1].

Data regarding baseline characteristics (age, gender, Body Mass Index (BMI), height), amount of contrast used, duration of the procedure, duration of cinegraphic imaging, types of catheters used, site of assessment (trans-femoral or trans-radial), and any preoperative complications such as cardio-embolic, bleeding, arrhythmic, mechanical complications, and so on were collected from patient records.

STATISTICAL ANALYSIS

The collected data with respect to all the study participants were entered into the Statistical Package for Social Sciences (SPSS) 21 software after data cleaning. The data were compiled and tabulated for further analysis. The categorical variables were calculated as percentages (%) and frequencies, and the continuous variables were presented as mean±Standard Deviation (SD).

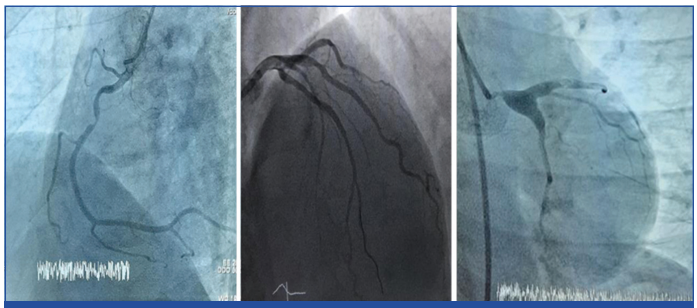
RESULTS

Among the 2849 enrolled patients, CAA was identified in 64 (2.24%), which included 38 (59.3%) male and 26 (40.6%) female. The average age of the patients was 56.6±12.6 years. As depicted in [Table/Fig-1], coronary anomaly with abnormal origin and course (Group A) was the most common type of coronary anomaly detected in 36 patients. [Table/Fig-2] shows a separate origin of the Left Anterior Descending artery (LAD) and Left Circumflex artery (LCX) from the left coronary sinus in LAO caudal view, with an absent Left Main Coronary Artery (LMCA). [Table/Fig-3] shows the most common subtype of coronary anomalies detected in 13 (0.45%) patients, with a myocardial bridge being detected in 8 (0.28%) patients. The LAD artery was found in all cases with a myocardial bridge, most commonly in distal locations in 6 (75%) cases. A total of 5 (0.175%) patients were found to have an anomalous origin of the coronary artery from the opposite sinus, of which 4 (0.14%) patients had an anomalous origin of the Right Coronary Artery (RCA) from the Left Coronary Artery (LCA), while 1 (0.035%) patient had an anomalous origin of the LCA from the right coronary sinus [Table/Fig-4]. A coronary anomaly of high ostial origin [Table/Fig-5] was observed in 4 (0.14%) patients. In 3 (0.1%) cases, the RCA was found to be the most common artery with a high ostial origin. A total of 3 (0.1%) patients had duplicate coronary arteries [Table/Fig-6], of which two patients had duplicate LAD and one patient had duplicate RCA. One (0.035%) patient each had a low ostial origin and a posterior sinus origin. And 1 (0.035%) patient had a single coronary artery arising from the right coronary sinus and traversing to the opposite side of the heart. A coronary anomaly with abnormal termination (Group B) was detected in 4 (0.14%) patients. All of the patients had coronary cameral fistulae, three of which originated from the RCA and one from the LAD. All of the abnormal arteries were discovered to drain into the right ventricle. Anomalies of intrinsic coronary arterial anatomy (Group C) were detected in 24 (0.84%) patients, among whom coronary ectasia was the most commonly detected in 23 (0.8%) patients. Ectasia involving all the coronary arteries was the most common pattern observed in the present study. Among isolated patterns, the LAD was the most common artery found to be involved with ectasia. One (0.035%) patient with coronary ectasia was found to have congenital stenosis of the ostium of the LCA [Table/Fig-7]. Absent LCX artery was detected in 1 (0.035%) patient.

Coronary anomaly		Prevalence (%)
Type	Subtype	
A. Anomalous origin and course	Absent left main trunk	13 (0.45%)
	High 'take off'	4 (0.14%)
	Low 'take off'	1 (0.035%)
	Origin from posterior sinus	1 (0.035%)
	RCA that arising from left anterior sinus	4 (0.14%)
	LCA arising from right anterior sinus	1 (0.035%)
	Single coronary artery	1 (0.035%)
	Myocardial bridge	8 (0.28%)
	Split RCA/LAD	3 (0.10%)
B. Anomalous termination	Arterio-cameral fistula	4 (0.14%)
C. Anomalous Intrinsic anatomy	Coronary ectasia	23 (0.80%)
	Absent LCX	1 (0.035%)
Total		64 (2.24%)

[Table/Fig-1]: Prevalence of Coronary Artery Anomalies (CAA) (N=64).

[Table/Fig-2]: Showing separate origin of LAD and LCX from left coronary sinus in LAO caudal view.
[Table/Fig-3]: Showing complete interruption of blood during systole due to myocardial bridge in mid segment of LAD in RAO cranial view (right side).
[Table/Fig-4]: Showing LAD and LCX arising from right coronary sinus in RAO cranial view. (Images from left to right)



[Table/Fig-5]: Showing high origin of RCA in LAO view.
[Table/Fig-6]: Showing duplication of LAD in LAO cranial view.
[Table/Fig-7]: Showing ostial stenosis with ectatic LMCA in RAO caudal view. (Images from left to right)

As depicted in [Table/Fig-8], out of the 64 cases of coronary anomalies, 13 (20.3%) patients developed different types of complications such as mechanical, embolic, arrhythmic, bleeding, CIN, left ventricular failure, etc. Complications were observed more commonly in Group A, with 10 (15.6%) cases, compared to Group B with 2 (3.12%) cases and Group C with 1 (1.56%) case. Both patients who developed mechanical complications were from Group A. One had a high-originated RCA and the other had RCAs from the left sinus. Both patients had ostial injuries, which were managed conservatively.

Out of the three cases who developed CIN, two cases were from Group A. One patient had a coronary anomaly with abnormal origin from the opposite coronary sinus with an anomalous course, and another patient had an absent LMCA. One of the remaining patients had an arterio-cameral fistula (Group B).

Both cases that developed Left Ventricular Failure (LVF) were in KILLIP class II, which subsided with intravenous furosemide. One patient had an arterio-cameral fistula arising from the LAD to the RV (Group B), and the other patient had a coronary anomaly with abnormal origin and course (Group A).

Out of the three patients who developed arrhythmias, one had coronary ectasia with severe ostial LCA stenosis (Group C) and developed VT, which reverted to normal sinus rhythm after catheter disengagement. The other two patients, who were from Group A, developed atrial fibrillation, which subsided with intravenous amiodarone infusion.

Type of coronary anomaly	Types of complications encountered during angiography					
	Mechanical 2 (3.12%)	Embolic 1 (1.56%)	Arrhythmia 3 (4.68%)	Bleeding 2 (3.12%)	LVF 2 (3.12%)	CIN (4.68%)
Group A Anomalous origin and course	2 (3.12%)	1 (1.56%)	2 (3.12%)	2 (3.12%)	1 (1.56%)	2 (3.12%)
Group B Anomalous termination	0	0	0	0	1 (1.56%)	1 (1.56%)
Group C Anomalous Intrinsic anatomy	0	0	1 (1.56%)	0	0	0

[Table/Fig-8]: Prevalence of arising complications during catheter guided angiography in the patients with coronary anomalies (N=64).

Both patients who developed a bleeding complication were in Group A. All were local at the access site and subsided after compression using a sandbag at the local site. One patient developed an embolic complication, which was from Group A.

DISCUSSION

In the current study, the prevalence of coronary anomalies was found to be 2.24%. This is consistent with the prevalence reported in other North Indian retrospective studies, which were 2.06% [6] and 2.02% [7]. In contrast, a Turkish retrospective study reported a lower prevalence of 0.9% [8], which may be attributed to regional differences in patient populations.

Among the coronary anomalies, a coronary anomaly with abnormal origin and course (Group A) was the most common type, detected in 36 (1.26%) patients [Table/Fig-1]. Similar findings were observed in other retrospective record-based studies conducted by Kashyap J et al. (1.29%) and Sohrabi B et al. (1.24%) [6,9,10]. However, a slightly higher prevalence of 1.56% was obtained in a Japanese prospective study, which may be due to the inclusion of patients undergoing CT coronary angiography with different subsets of indications [6,9,10].

In the current study, the most common anomaly in Group A was the separate origin of LAD and LCX (absent LMCA), observed in 0.45% of patients [Table/Fig-1]. The prevalence of absent LMCA was found to be 0.37% in the north Indian studies conducted by Kashyap J et al. and Diwan Y et al. [6,11].

Anomalous intrinsic anatomy of the coronary artery (Group C) was the second most common group of coronary anomalies, observed in 24 (0.84%) cases [Table/Fig-1]. This is consistent with the prevalence of 0.7% reported in a north Indian study [6].

Coronary ectasia was found to be the most common coronary anomaly among Group C and among all patients with coronary anomalies, observed in 23 (0.8%) cases [Table/Fig-1]. In a recent study conducted in China, the prevalence of coronary ectasia was reported to be 1.6% [12]. However, another recent study reported a prevalence of 0.85%, which aligns with the findings of the present study [13].

Coronary anomalies with anomalous termination (Group B) were less frequent, observed in 4 (0.14%) cases [Table/Fig-1], with the RCA being the involved artery. Similar findings were observed in a study with a prevalence of anomalous termination at 0.1% [14].

The current study is the first to determine the prevalence of different types of complications arising during angiography in patients with coronary anomalies, with special regard to their subtypes. In the present study, as depicted in [Table/Fig-8], mechanical complications such as ostial injury were invariably observed only in Group A (coronary anomaly with abnormal origin and course). Defining the origin and course of coronary arteries in this group of patients is extremely important. Abnormal ostia (non-circular and ectopic), intramural or malignant interarterial course, and a higher association of CAD are important characteristics of this group of coronary arteries [3]. They are also the most common cause of sudden cardiac death in athletes after Hypertrophic Cardiomyopathy (HCM) [15]. Engaging the ostium and detecting the course of such an artery can be challenging and time-consuming. Injury to the ostium during engagement of an anomalous coronary artery is not uncommon during angiography [16]. Arrhythmias can commonly occur due to obstruction of the abnormal ostium as a result of imperfect manipulation of the catheter [17]. The higher prevalence of complications such as CIN, LVF, arrhythmia, etc., in these patients can be attributed to either a higher association of obstructive CAD or increased use of contrast [4], during multiple cine views or during the exchange of a guide catheter in order to find the abnormal origin and course of the artery [18]. Bleeding complications commonly arise due to excessive use of angiographic procedures during a prolonged procedure. The use of appropriate manoeuvers, types, and sizes of catheters, and cine views can help avoid iatrogenic complications such as bleeding, CIN, and LVF, while limiting the use of contrast and anticoagulants, thus reducing mechanical complications [18]. Being prepared and alert in catheterisation laboratories can aid in reversing critical situations.

Limitation(s)

- The study population consisted of patients with chest pain suggestive of CAD who underwent coronary angiography. Therefore, the prevalence of coronary anomalies derived from their angiographic records may not represent the actual prevalence of coronary artery anomalies in the general population.
- This was a single-center study, and studies involving multiple centers would provide a better idea of the actual magnitude of coronary artery anomalies.
- Coronary angiography may not be able to demonstrate complex anomalies in detail. MDCT coronary angiography is a better procedure for detailing complex coronary anatomy.
- Since the study is retrospective in nature, some important anatomical and clinical findings may have been missed during recording.

CONCLUSION(S)

A coronary anomaly with abnormal origin and course is the most common type of coronary anomaly. The prevalence of life-threatening procedural complications is higher in patients with coronary anomalies of abnormal origin and course during catheter-guided angiography. Difficulty during engagement of the ostium and detection of the course, along with excessive use of contrast and anticoagulants (to find out the abnormal and malignant origin and course of the artery), and a higher association of significant obstructive CAD in this subgroup of patients, may be important contributing factors to the higher prevalence of complications during angiography. The utilisation of appropriate manoeuvers, types and sizes of catheters, views, and contrast during the procedure can prevent disastrous complications.

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