Original Article

Coronary Artery Variants and Anomalies Observed a Tertiary Care Hospital of Bangladesh using Coronary Angiography

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Abstract:

Many coronary anomalies do not cause symptoms and are recognized only at the time of autopsy. The incidence of coronary artery anomalies (CAAs) varies from 0.2% to 8.4%. Knowledge of such anatomical variations is important as coronary procedures are regularly performed these days. The aim of the study is to find the coronary dominance pattern, intermediate coronary artery (IMCA) frequency and CAA incidence in our hospital, and compare them to those in the literature. The medical reports of 987 patients who had undergone coronary angiography (CAG) between December 2017 to October 2018. Dominance pattern and presence of IMCA and CAA were recorded. CAAs were described using two different classifications: Angelini and Khatami's classification, and a new modified classification that was derived from Angelini and Khatami's classification. Some procedural details and clinical features of the patients with CAA were also investigated. Coronary dominance pattern was 79.6% right coronary artery, 13.2% circumflex artery and 7.2% co-dominant. IMCA was present in 79 (8.0%) patients. The incidences of overall anomaly were 2.7% and 1.4%, according to the different classifications. Incidences of myocardial bridge(MB), coronary arteriovenous fistulae and aneurysms were 1.1%, 0.2% and 0.3%, respectively. In conclusion, it may be stated that, CAAs are generally asymptomatic, isolated lesions. Some may lead to anginal symptoms, myocardial infarction, arrhythmia or sudden death. We found that CAA was associated with increased radiation and contrast exposure in patients who underwent CAG. This risk could be reduced if appropriate catheters were designed and training programs on ostial cannulation were developed.

Key Words: *Coronary angiography.*

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Introduction:

The term coronary artery anomaly refers to a wide range of congenital abnormalities involving the origin, course and structure of epicardial arteries. By definition, these abnormalities occur in less than 1% of the general population. Coronary artery anomalies are frequently found in association with other major congenital cardiac defects. This article, however, is focused on isolated coronary artery anomalies (i.e. in the absence of other major congenital cardiac defects). With an increasing number of coronary angiography (CAG) procedures, coronary invasive procedures and cardiac bypass surgeries performed each day, knowledge of the variations, anomalies and anatomical pattern of coronary arteries is gaining in importance. Although many individuals have a normal coronary anatomy, variations and anomalies are not unusual, and may lead to complications during procedures[1].

The LMCA originates from the left sinus of Valsalva (SV), while the RCA originates from the right SV. The LMCA bifurcates into the left anterior descending (LAD) artery and the circumflex artery (LCX). An additional artery called the intermediate artery (IMA) may arise at the bifurcation of the LMCA, forming a trifurcation.

The artery that supplies the posterior descending artery determines coronary dominance. Approximately 70%–80% of the general population is right-dominant (i.e. supplied by the RCA), while 5%–10% is left-

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dominant (i.e. supplied by the LXA) and 10%–20% is co-dominant (i.e. supplied by both the RCA and LCX)[2-4]. A more accurate definition of dominance refers to the arterial supply to the atrioventricular nodal artery, which is generally supplied by the RCA[2-4].

While there is still no consensus regarding the differentiation between coronary artery variants and anomalies, Angelini et al.have proposed that any variation from the normal anatomy that is found in more than >1% of the general population be considered avariant, while those occurring in <1% of the population may be designated as anomalies.

The coronary dominance pattern, presence of IMCA and incidence of CAAs may vary depending on the population studied. In the present study, we aimed to identify the coronary dominance pattern, IMCA frequency and incidence of CAAs among the patients in our hospital who had undergone CAG, and compared our results with data found in the literature.

Methods:

The CAG reports of 987 patients (659 men, 329 women) who underwent CAG in our hospital between December,2016 to October, 2018 were retrospectively investigated. Their catheterization reports were also analyzed. Patients who were identified to have CAAs were selected for further assessment. The CAG images were reviewed and re-evaluated if necessary.

Coronary dominance pattern and the presence of IMA and CAA were recorded. CAAs were grouped according to the systematic anatomic approach developed by Angelini and Khatami, which is recognized as the most valid classification for CAA[13].

A simplified modification of Angelini and Khatami's classification is currently used in clinical practice[19]. It divides CAAs into two groups: Group A, anomalies of origin and distribution; and Group B, intercoronary communications and coronary artery fistulae. Both classification systems were used to evaluate the CAAs in the present study.

A myocardial bridge (MB) is a condition in which a coronary artery tunnels through the myocardium. Coronary artery ectasia is the dilatation of a coronary artery segment to a diameter 1.5 to two times that of the adjacent segment, whereas coronary aneurysm is the dilatation of a coronary artery segment to a diameter more than two times that of the adjacent segment.

Incidence proportion (i.e. cumulative incidence) is the number of new cases within a specified time period divided by the size of the population initially at risk. In the present study, the angiographic incidence of CAAs was calculated as the number of CAAs divided by the total number of patients enrolled in the study (n = 987). Anomaly incidence is defined as the percentage of a specific anomaly among the total CAAs detected in the study.

Patients who had CAAs, according to the modified classification system for CAA, were re-analyzed in the present study. Unlike other studies found in the literature, some procedural details (including fluoroscopy time, the volume of contrast media used and the number of catheters used) and clinical features of patients with CAA were also investigated.

Results:

The mean age of the 987 patients who had undergone diagnostic CAG between December, 2017 to October,2018 was 50.3 ± 10.3 years. Most of the patients were men (66.7%, n = 659). The most frequent CAG indications were chest pain, positive stress test and wall motion abnormality on echocardiography. The coronary dominance pattern in our study was 79.6% RCA, 13.2% LCX and 7.2% co dominant. There was no significant difference in the coronary dominance pattern between the genders. IMCA was detected in 79 (8.0%) patients and found to be significantly more frequent in male patients than female patients (13.0% vs. 6.7%, $p < 0.001$).

According to Angelini and Khatami's classification, the overall incidence of CAAs was found to be 2.7%. According to the modified classification, the incidence of Group A and Group B anomalies was 1.2% and 0.2%,

respectively. Based on the modified classification, 11 (87.2%) patients had anomalies of origin and distribution (i.e. Group A), while 2 (12.8%) had intercoronary communications and coronary artery fistulae (i.e. Group B). As the modified classification does not accept MB and coronary artery aneurysms as coronary anomalies, the incidence of CAAs was found to be 1.4%. The coronary dominance pattern, IMA frequency and incidence of CAAs are summarised in Table I.

Table-I

Coronary dominance pattern, intermediate artery frequency and incidence of CAAs in the study cohort (n = 987), according to the two classification systems.

Parameter	No. of patients	Angiographic incidence (%)	Anomaly incidence (%)
Coronary dominance pattern			
Dominant right coronary artery	785	79.6	–
Dominant circumflex artery	130	13.2	–
Co dominant arteries	71	7.2	–
Intermediate artery frequency	79	8.0	–
Incidence of CAA			
Angelini and Khatami's classification			
Anomalous pulmonary origins of the coronary arteries	–	–	–
Anomalous aortic origins of the coronary arteries	12	1.2	44.7
Myocardial bridge	10	1.1	39.5
Coronary arteriovenous fistulae	2	0.2	6.6
Coronary artery aneurysms	3	0.3	9.2
Coronary artery stenosis	–	–	–
Total incidence	26	2.7	–
Modified classification			
Group A (anomalies of origin and distribution)	11	1.2	87.2
Group B (intercoronary communications and coronary artery fistulae)	2	0.2	12.8
Total incidence	13	1.4	–

Note: Angiographic incidence calculated using the total number of patients enrolled in the study as the base. Anomaly incidence defined as the percentage of a specific anomaly among the total CAAs detected via the specific classification system. CAA: coronary artery anomaly

Fig.-1: *Angiogram shows the circumflex artery (CXA) originating from the right coronary artery (RCA).*

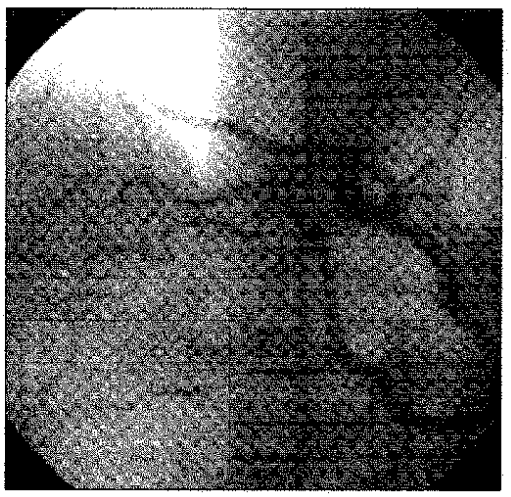

Fig.-2: *Angiogram shows the separate origin of the left anterior descending (LAD) artery and circumflex artery (CXA) from the left sinus of Valsalva, with absence of the left main coronary artery.*

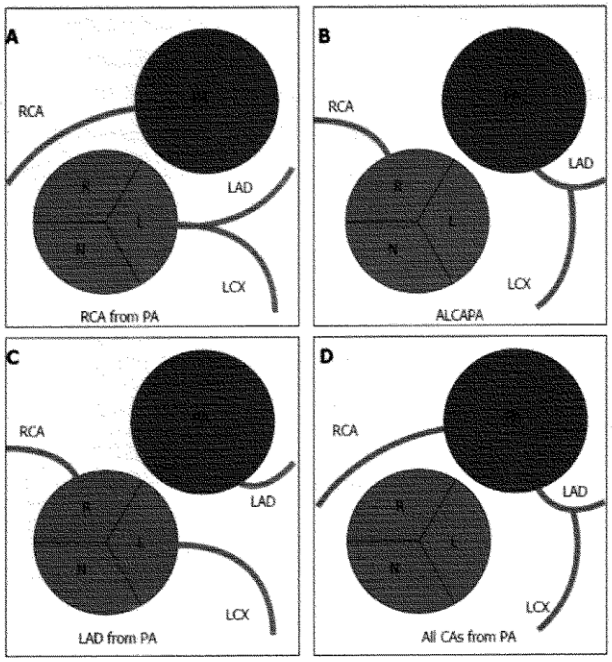

Fig.-3: *Anomalies of origin from pulmonary artery (A-D) R: Right sinus of Valsalva; L: Left sinus of Valsalva; N: Non-coronary sinus; PA: Pulmonary artery;RCA: Right coronary artery; LAD: Left anterior descending; LCX: Left circumflex; ALCAPA: Anomalous left coronary artery from pulmonary artery;CAs: Coronaryarteries.*

LMCA was the most common anomalous vessel in the present study. The incidence of LMCA absence was 0.9%. In two patients, the LMCA originated from the CXA, while in two patients it originated from the LAD artery; only one patient had an LMCA that originated from the right coronary circulation (i.e. the right SV or RCA). The RCA originated from the left coronary circulation (i.e the left SV or left coronary arteries) in twopatients. CAF was detected in 2 (0.2%) patients – six originated from the RCA and four from the CXA or LAD artery. MB was detected in 10 (1.1%) patients and at a higher frequency among the male patients than the female patients (1.4% vs. 0.4%, p = 0.02). Aneurysms were detected in 3 (0.3%) patients. Anomalous origin of the coronary arteries from the pulmonary artery or atretic coronary arteries was not observed in the present study. The most common clinical presentations of the patients with CAA were: atypical chest pain (61.5%); typical angina (25.6%); acute coronary syndrome (9.0%); and syncope (3.9%). The mean duration of fluoroscopy was 9.1 ± 4.8 (range 4–21) minutes. The mean volume of contrast media used was 81.4 ± 59.8 (range 30–350) mL.

Discussion:

The coronary dominance pattern, presence of IMA and incidence of CAAs may vary in different CAG series, depending on thecharacteristics of the study population. The coronary dominance pattern in the present study was 79.6% RCA, 13.2% CXA and 7.2% co-dominant, consistent with that found in the literature[14]. The dominance pattern was similar between genders in the present study. IMA was present in 79 (8.0%) patients, a higher percentage than that reported in the literature[4]. IMA frequency was also found to be high in a study that used 64-slice computed tomography (CT) CAG[14]. In the present study, IMA was observed more frequently among the male patients. CAAs were found in 0.2%–1.3% of CAGs and 0.3% of autopsies in the literature[6,7-12].

The overall incidence of CAA in our study was 2.7% based on Angelini and Khatami's classification. As MB and coronary artery aneurysms are not classified as CAAs in the modified classification, the incidence of CAAs was found to be only 1.4% using the modified classification. Based on the modified classification, 87.2% of the CAAs were abnormalities in the origin or distribution of a coronary artery (i.e. Group A) and 12.8% were abnormal fistulae (i.e. Group B). The incidences of CAAs in the present study, according to both classifications, were higher than most of the reported values in the literature[6,7-12]. The incidence of CAF was also relatively high in the present study[6,7,11,14].

Similar to some large studies in the literature[7,8,11,12], separate origin of the LAD artery and CXA from the left SV (i.e. absence of the LMCA) was the most common anomaly in the present study. Angiographic incidence of the absence of the LMCA was reported to be 0.23% and 0.58% in two studies performed in Turkey[7,13]. In the present study, the LMCA was the most common anomalous vessel and the incidence of absence of the LMCA (Fig. 1) was 0.9%, higher than those reported in the aforementioned studies.

Anomalies of the LMCA or LAD artery have more clinical significance than those of the CXA. In the present study, two patients had anomalous origin of the LAD artery from the right coronary circulation. Although the incidence of origin and distribution anomalies of the LAD artery was

generally reported to be quite low in the literature, Tuncer et al found the angiographic incidence of this anomaly to be 0.017%[10].

A CAF is an abnormal connection between one of the coronary arteries and another structure. The frequency of this condition is 1/50,000 at birth and 1/500 at cardiac catheterisation[9,13]. More than 50% of these fistulae have a connection with the RCA. Most of them drain into the right ventricle (40%), right atrium (25%) or coronary sinus, while some drain into the pulmonary artery, left atrium or left ventricle[7,8]. In some series, fistulae were as common as CAAs (21%)[9]. In the present study, we observed ten CAFs and the angiographic incidence of CAFs was 0.2%. Six had a connection with the RCA (Fig. 3), while four had a connection with the CXA or LAD artery. These results are similar to those of Yamanaka and Hobbs' study, in which the angiographic incidence of CAFs was 0.15% and the percentage of CAFs was 13% among the CAAs[8]. In one study from Turkey, the angiographic incidence of CAFs was found to be 0.04% and the percentage of CAFs was 5% among CAAs[7]. The angiographic incidence and percentage of CAFs among CAAs were found to be higher in another study from Turkey (0.45% and 18.6%, respectively)[13].

In the present study, of our patients 3 (0.3%) had aneurysms and male dominance , similar to that observed in coronary artery diseases and has to be treated as coronary artery disease[1,7,12].

Conclusion:

In the present study, there was a higher incidence of CAAs in our study population. Although CAAs are generally asymptomatic, isolated lesions that are usually not associated with congenital heart disease or atherosclerosis, some may lead to anginal symptoms, myocardial infarction and sudden death. The recognition of coronary anatomical patterns, variations and CAAs is very important, especially when dealing with patients who are scheduled for coronary angioplasty or cardiac surgery. Further prospective studies are required to evaluate the incidence and prognosis of CAAs.

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